POWER ECONOMY COMMITTEE

REPORT OF

STUDY GROUP No. V

GOVERNMENT OF INDIA
MINISTRY OF IRRIGATION & POWER
NEW DELHI

GOVERNMENT OF INDIA
MINISTRY OF IRRIGATION AND POWER
POWER ECONOMY COMMITTEE

IMPLEMENTATION OF POWER PROJECTS

REPORT OF STUDY GROUP-5

Convener	
Shri B. V. Deshmukh	Chairman Bhakra Management Board.
Members	
Shri M. W. Goklany	Chief Electrical Engineer, Damodar Valley Corporation.
Shri K. M. Chinnappa	Joint Managing Director, Tata Electric Companies.
Shri M.N. Chakravarti	Adviser (Power)., Deptt. of Atomic Energy.
Shri B. N. Baliga	Chief (Power), Planning Commission.
Shri K. C. Krishnamurthi	Director, Central Water & Power Commission.
Shri K. L. Vij	Chairman, Power Economy Committee.
Shri S. N. Vinze	Member-Secretary, Power Economy Committee.

1—783 I&P/71

INDEX

1. SCOPE

The Resolution setting up the Power Economy Committee states that "in order to efficiently utilise the limited resources of the country to take up required schemes for generation, transmission and distribution of power, which are largely capital-intensive in nature, it is necessary to implement measures for bringing down costs of power development. This would require a detailed review of measures taken by Government to ensure utmost expediency in the construction of power projects....."

The Study Group-5 has been set up by the Power Economy Committee for carrying out this review. The relevant term of reference of the Power Economy Committee sets out the task as follows :—

> "To review the causes of delay in the execution of the power projects, to suggest measures for improving the manner of implementation of power projects and reducing construction periods."

---

2. SURVEY OF PRESENT POSITION

1. The Fourth Five-Year Plan provides an outlay of Rs. 2,530 crores on power development programmes (Public and Private Sectors) and envisages that the installed capacity in the country will increase from 14.29 GW in 1968-69 to 23.0 GW at the end of the Plan period. The power plan lays emphasis on development of transmission and distribution system and on formation of grid system on a scale commensurate with the increase in power generating capacity for enabling maximum utilisation of generating capacity and also for improving power supply conditions in the country. A large scale programme of rural electrification is contemplated for supporting food production programme and also for providing the infra-structure for development of agro-based small and rural industries.

2. In 1969-70, the first year of the Plan, a target of 1.63 GW was fixed raising the total installed capacity in the country to 15.92 GW. The actual achievement, however, amounted to only 1.19 GW. In 1970-71, the target for additional installed capacity is 1.32 GW. This includes the capacity of those projects which were targeted to go into operation in 1969-70, but actually did not. The broad indications available now are that the actual capacity that may go into operation during the year would be about 0.7 GW. (Some of the plants those were expected to go into operation in 1968-69 may not go into operation even in 1970-71 because of delay in supply of parts and components etc.).

3. The schemes expected to provide benefits during the Fourth Plan are mostly those schemes which were approved during the Third Five-Year Plan or earlier. It may be recalled in this connection that in the erstwhile Draft Fourth Plan (1966-71), a target of 20 GW was adopted. As against this, it is anticipated that only about 16.2 GW would be in operation by the end of 1970-71. Schemes such as Beas, Yamuna Stage-II, Ramganga, Chambal Stage-II, Bassi Hydel Scheme, Badarpur in the Northern Region; Patratu (400 MW), Balimela Hydro-electric Scheme (360 MW) in the Eastern Region; Koyna Stage-III, Vaitarna, Ukai Hydro Schemes in the Western Region; Ramagundam Thermal, Ennore Thermal, Parambikulam, Kodayar, Kuttiadi, Sholayar and Idikki Hydro-electric Stations in the Southern Region were expected to be commissioned by the end of 1970-71. These are now expected to go into operation only during the next 3 years. Civil works are behind schedule on almost all these hydro-electric schemes. In the case of most of the above thermal stations, erection of plant and equipment is yet to be commenced. A third factor that will delay completion of some of the schemes is the delay in supply of plant and equipment by the public sector manufacturing units—Heavy Electricals (India) Ltd., Bhopal and Bharat Heavy Electricals Ltd.

4. A study of the situation obtaining indicates that the principal factor that will determine the power position in the country during the Plan period is the success achieved in putting into operation the generating sets according to schedule and achieving the target of 23 GW of installed capacity. Punjab and Haryana are facing power shortage at present because U.B.D.C. (45 MW), Bassi (45 MW), Beas Hydel Schemes (4 $\times$165 MW), Rajasthan Nuclear Station Stage-I (200 MW), Badarpur (3 $\times$ 100 MW) have not gone into operation and there have been breakdowns of generating units in Delhi Power Station and partial drought conditions in the catchment area of Bhakra Reservoir. Uttar Pradesh is facing shortage because parts and components of thermal sets for Obra (50 MW), Harduaganj (55 MW) and Obra Hydel sets (3 $\times$ 33 MW) have not been supplied so far. In addition, Rihand Reservoir has not been replenished because of scarce rains in the catchment area of the Reservoir. The loss of capacity due to non-replenishment of Reservoirs could have been made up from new schemes, had they gone into operation as anticipated earlier.

5. The 5th as well as the 6th Annual Electric Power Surveys conducted by the CEA respectively in 1968 and 1970 clearly indicate a power shortage in the coming years. The estimates of availability of generating capacity upto 1973-74 are based on power development schemes which have already been approved. If the loads forecast are to be met, it will be necessary to sanction additional schemes for augmenting the generation and transmission facilities without any delay, as these require a number of years of pre-construction activity before the benefits can become available.

6. The position thus is serious. Electric power being one of the principal members in the 'Infra-structure' of a developing country like India, adequate importance has to be attached to power development. Any power shortages in any part of the country carry with them a frightful prospect of serious retardation of industrial and agricultural growth. The problem has, therefore, to be tackled on many fronts. These would include improving of functioning of the existing power generation and transmission facilities, better plant availability and efficiency leading to better utilisation of existing installations, integrated operation of power systems to ensure utilisation of surplus power in some States in the neighbouring deficit States and to increase the system load carrying capacity, reduction of transmission losses and so on. The matters are already engaging the attention of other Study Groups of Power Economy Committee and the work of the present Study Group is restricted to the question of efficient and timely execution of power projects. In view of the crucial importance of this topic, this is already receiving attention of the Government at different levels and the following recent developments in this connection may be noted.

7. The Fourth Conference of the Chairman of the State Electricity Boards, held in New Delhi in April, 1970, has passed the following resolutions which have a bearing on this subjects :

(i) Measures to be taken for expediting the commissioning of power stations according to schedule.

(ii) Evaluation of indigenous manufacture of generating capacity.

(iii) Supply of essential materials for power schemes.

(iv) Central Generation through Regional Agencies.

These are given in Appendix-I.

Further, the Fifth Conference of the State Ministers of Irrigation and Power held in September, 1970 at Ootacamund has urged the need for providing additional funds during the Fourth Plan for investment of larger amounts on continuing schemes of generation and transmission and for initiating advance action on such schemes as would yield benefits during the Fifth Plan.

8. **Construction Equipment :** The Ministry of Irrigation and Power had appointed a committee to study the working of the construction equipment employed on major power projects (Hydro Projects) and to recommend steps for improving their operational conditions and better utilisation. The Committee has found that more than 50 per cent of the equipment is lying idle for want of spare parts. This appears to be a major factor in delaying execution of civil works and the problem needs to be tackled on a more realistic and speedy manner than hitherto.

Ministry of Irrigation and Power has taken up the issues regarding import of spare parts for construction equipment, expediting delivery of generating plant and equipment and expediting the civil works, etc. While considerable improvement may be expected in restoring construction equipment into working order if foreign exchange is readily made available for import of spare parts, the progress both in the field and in the manufacturers' works will have to be stepped up appreciably before the target of 23 million kW can be achieved.

9. **Materials for Transmission Lines :** During the Plan period, Rs. 722 crores are proposed to be spent on transmission and distribution programmes and Rs. 445 crores on rural electrification programmes. Nearly 60 per cent of the outlays on these two programmes would be spent on transmission and distribution materials, *i.e.* transmission towers and line supports, conductors and steel earth wire, etc. These materials have to be transported to interiors where perhaps only cart tracks exists. There should be an even flow of materials as well for works to be executed in an economic manner. Presently, there is an acute shortage of steel and aluminium. Consequently, the States do not get the materials as and when they want. The transmission and distribution programme is being affected by this. This will delay utilisation of available capacity and also delay benefits from inter-State transfer of power. These issues are being tackled by the Ministry of Industrial Development. Arrangements have been made for issue of import licences for import of 24,000 tonnes of aluminium to supplement the country's production of E.C. grade aluminium, Imported aluminium is about Rs. 500 per tonne costlier than the indigenous metal. Import of steel is also contemplated. The effects of these steps have, however, yet to be felt and, therefore, require to be watched. It is necessary to ensure that steel, aluminium, copper and such other important raw materials required for the electricity generation, transmission and distribution industry are available in adequate quantities throughout the Plan period.

3. MAGNITUDE OF THE TASK

At this stage, it is necessary to take note of the magnitude of the task set by the Planners for the electric power development.

1. Figure-I shows the growth of installed capacity in the country for the different modes of power generation from 1955 onwards year by year. The data has been plotted on a semi-log scale in order to bring out the trends clearly. The data for the past years are the actuals and the data for the Fourth Five-Year Pan are based on the schemes actually taken up. (These latter are listed in Table I year by year). Beyond the Fourth Plan are shown the different rates of growth visualised by Planners from time to time. It will be seen that there is a general unanimity of approach regarding the rate of growth required in respect of different categories of power generation, *viz.* thermal, hydro and nuclear. The rate of growth in respect of the hydro-electric installations particularly seems to accelerate much more rapidly than in the case of thermal and nuclear power. The rationale of this is discussed at length in the Report of Study Group-3. This is a matter of great significance for the present study. In the case of the hydro-electric installations, a major proportion of the project costs is spent on work at the project site itself. Further, a very wide variety of techniques of civil and hydraulic construction are involved in the hydro-electric construction work and these vary widely from site to site. The quantities of materials as well as man-power employed per MW on the construction work is much higher compared to the thermal and nuclear installations, the size of generating units generally employed in hydro-electric installations are much smaller than those that would be employed in the newer thermal and nuclear installations. This would lead to a comparatively much larger number of generating units and hence a correspondingly large magnitude of project work than would be indicated merely by the rate of increase of MW capacity shown in the figure. However, as discussed in the report of Study Group-3, hydro projects provide the most economic source of power and have, therefore, to be developed on as large a scale as possible.

2. Figure-2 shows the rate of growth of the transmission facilities in a similar manner. One of the findings of another Study Group of Power Economy Committee (No. 2) is that in the past, the investment on power transmission and distribution has not been what is required even for the meagre power generation facilities created. Correction of this position would require a steep rise in the rate of growth of the transmission facilities in the coming years. This would also be necessary for promoting integrated operation of power systems so as to maximise the benefits from the existing power generation facilities, and for improving the quality and reliability of power supply. This has been discussed in detail in the Report of Study Group-2. Table 2 give the break-up of growth of transmission facilities on the basis of transmission line voltages.

3. Figure-3 shows the past performance in respect of capacity additions year by year. The principal feature is wide fluctuations in the performance from year to year. This has been due to a variety of causes discussed later. However, it is pertinent to note here that such wide fluctuations of performance from time to time also indicate scope for better and higher utilisation of the project construction capabilities. If the resources in men, equipment, materials and organisation are properly programmed to achieve a more uniform level of performance from year to year, a higher level of performance should be possible even within our existing capabilities.

---

4. COMMITTEE ON SHORTFALL IN GENERATION DURING THE THIRD FIVE-YEAR PLAN

1. The subject has been considered in great detail once before by the Committee set up by the Government of India under the Chairmanship of Shri K. P. S. Nair. During the first two Plan periods (April 1951 to March, 1961), the installed generating capacity in the country had increased from 2.3 GW to 6.77 GW. The target for the Third Plan (April 1961—March. 1966) was set at 12.695 GW when the Plan was formulated in September, 1961. Later, additional schemes were also sanctioned to be taken up for implementation in the Third Five-Year Plan. The actual achievement at the end of the Third Plan was, however, only 10.1 GW, indicating a shortfall of 2.525 GW from the original Plan targets. New installation to the extent of only 4.493 GW was achieved in the Third Plan against 7.018 GW targetted, thus showing a shortfall of nearly 36%. The terms of reference of this Committee were as follows :—

"(a) To examine the reasons for delays in the implementation of thermal and hydro-electric projects in the Third Plan.

(b) To suggest measures—

(i) to accelerate work of planning, preparation of designs, construction of civil and ancillary works, erection, testing and commissioning of equipment, etc.

(ii) to ensure timely procurement of materials and equipment—simplification of procedures thereof.

(c) To indicate the extent of co-ordination required to be done by the Central agencies, such as C.W. & P.C., Ministry of Irrigation and Power, etc."

2. This Committee thus covered substantially the same ground as that covered by this Study Group. The main difference is that the work of the Nair Committee is restricted to generation schemes. Moreover, the conditions obtaining in the country have undergone changes and the relative importance of the different factors have also now entered the picture. Just the same, the conclusions and recommendations of the above Committee are still of very great value. Relevant extracts from this Report of the Shortfall Committee are appended (Appendix-2) for ready reference. The Study Group feels that the conclusions and recommendations contained therein are still valid. These have been taken into account in the present deliberations also.

---

5. CAUSES OF DELAYS

1. The principal causes of delays have been listed by the Shortfall Committee in their report as follows :

"I. **Thermal**

1. Lack of adequate project data.
2. Inadequate investigation before finalising technical project report.
3. Major change in scope of work.
4. Delay in site selection and land acquisition.
5. Delay in issue of authorisation by Central and/or State Authorities.
6. Delay in foreign exchange tie up.
7. Deficiency in organisation for planning and engineering the project.
8. Delay in appointment of consultants wherever required.
9. Lack of local organisation of consultants resulting in delay in communicating decision.
10. Delay in procurement of equipment due to :
    (a) late issue and late finalisation of tenders;
    (b) procedural delays in processing through DGS&D;
    (c) processing of foreign exchange release by Govt. of India.
11. Delay in levelling and dressing at site due to—
    (a) inaccessible nature of site;
    (b) delay in procurement of construction equipment.
12. Late receipt of erection drawings.
13. Delay in procurement of construction equipment like tower crane, Gantry crane etc.
14. Shortage of Cement and Steel, welding rods, explosives, etc.
15. Late arrival of erection specialists.
16. Delay in delivery of equipment due to :—
    (a) failure of supplier to keep up schedule;
    (b) lack of ships, port strikes etc.;
    (c) over carriage of equipment;
    (d) impounding of equipment in Pakistan.
17. Difficulties in transporting equipment to site—
    (a) in moving over dimensional packages on railway due to restrictions imposed by bridges, tunnels etc.;
    (b) due to lack of suitable rolling stock etc.;
    (c) due to difficult terrain and lack of proper access routes.
18. Delays in getting replacement for items of equipment damaged or lost in transit.
19. Lack of proper planning and co-ordination of various construction schedules and failure to anticipate delay in case of critical phase of construction activity in advance.
20. Labour strikes and civil disturbances.
21. Unprecedented rains and floods.
22. Difficulties experienced due to change in the course of lean water flow in river.
23. Change in top personnel in the course of implementation of project.
24. Stoppage of work due to enemy action.

II. **Hydro**

1. Inadequate investigation before finalising technical project report.
2. Major change in the scope of work like :
    (a) change in the location of dam.
    (b) change in design of dam foundation.

(c) change in design of Water Conductor System

(d) change in location of power station and switch yard.

(e) change in generator capacity.

3. Delay due to inter-State aspects.

4. Delay in issue of authorisation by Central and/or State authorities.

5. Delay in foreign exchange tie-ups.

6. Change in key personnel in the course of advance planning and execution.

7. Delay in procurement of equipment due to—

(a) late issue and late finalisation of tenders;

(b) procedural delays in processing through D.G.S.&.D.

(c) processing of foreign exchange release by Government of India.

8. Delay in procurement of construction equipment.

9. Shortage of Cement and Steel, welding rods; explosives, etc.

10. Shortage of spare parts for construction equipment.

11. Late arrival of erection specialists.

12. Delay in delivery of equipment due to failure of supplier to keep up schedule.

13. Difficulties in transporting equipments to site—

(a) in moving over dimensional packages ages on railway due to restrictions imposed by bridges, tunnels, etc.

(b) Due to difficult terrain and lack of access roads.

14. Unpredecendented rains and floods.

15. Land acquisition and rehabilitation."

III **Nuclear:**

In addition to the causes of delays listed under thermal, due to the special features of atomic power stations certain additional causes of delays exist. These are .—

1. Protracted negotiations have been generally necessary before finalising the various agreements.

2. Long delivery period in the supply of equipment and machinery, both by the Indian and Foreign suppliers.

3. Locating Indian suppliers of equipment to meet standards and other requirements in the fabrication of the various equipments to achieve maximum indigenisation.

4. Technical improvements which had become necessary during the construction phase.

2. Besides, these, the much larger scale of activities and complete dependence on indigenous manufacture of power plant and equipment have introduced some further difficulties. The larger scale and complexity make it necessary now to adopt the modern management techniques developed recently and to remove or reduce the Administrative difficulties. In the following Sections, the different factors influencing the execution of Projects from conception to commissioning, are discussed.

6. PLANNING

1. For proper planning of the power projects, a thorough understanding of the future trends in the growth of the requirements of electrical power and electrical energy is essential. There has been a growing awareness of this from Plan to Plan. Presently, the Central Electricity Authority undertakes an Annual Electric Power Survey through a High Power Committee appointed for the purpose. The 5th Annual Electric Power Survey was published in 1968 and the 6th one is being published in 1970. The periods of both these Surveys extend to 1973-74 covering the 4th Five-Year Plan period. Experience of recent years has, however, shown that these surveys are not yet adequate in many ways.

1.1. Firstly, there has been a consistent sizable gap between these figures of demand potential and the actual load demands at any time. The lags in the growth of demand in States like Kerala, Mysore, Madhya Pradesh, Orissa, Bihar, West Bengal, etc. notwithstanding the fact that adequate generating capacity had been built up is noteworthy. These have occurred in spite of considerable delays in the implementation of power projects. On the other hand, there have been pockets of power shortages in certain States even when adequate generating capacity had been provided. These have been due to non-availability of adequate transmission and distribution facilities and there should be some way of noticing such possibilities in advance. Improvements in the methods are, therefore, necessary for arriving at assessments which will be closer to the actuals and can be taken as a basis for definitive long-term planning. In the past decade, the rate of growth has been of the order of 11% per year. The Study Group feels that an annual addition of at least 12—15% must be planned for each region.

1.2. Secondly, these power surveys do not look sufficiently far into the future. Experience all over the world has shown that in order to keep up with the growing loads, a fairly large programme of construction has to be in hand all the time. A case in point is the experience of the Central Electricity Generating Board of U.K. as given in Table-5 and Appendix-3 which is an extract from the 1967-68 Annual Report of CEGB. It is seen that the new plants under construction or planned at the end of each year have been of the order of over 10 times the capacity commissioned during the year. The lead time for the thermal projects in U.K. also works out to about 7-8 years and it is, therefore, clear that definite work on any project must be initiated at least that much in advance of its required commissioning date. This is not possible when even the power surveys do not extend over more than 4-5 future years.

2. It is now well recognized that the grouping of projects by plan periods of 5 years has resulted in jerky progress. This is highly uneconomical. The planning and execution of power projects should, therefore, be a continuous process wherein the picture of the targets to be achieved, say, 15 years hence is always available in outline and the details are filled in as the years progress. The perspective plan for the next 15 years should be available at any point of time and every year such plan should be up-dated and extended to cover the future 15 years. Advance action in respect of preliminary investigations and designs and estimates should proceed and the proposals for the next 10 years should be on a more definite basis and should indicate the specific project to be undertaken and their time-table of the major stages. The plans for the first 5—7 years should be on a very definite basis at any time.

3. The present position regarding the above proposals for a suitable advance action programme is not a very happy one. At the end of the Third Five-Year Plan, there were 25 GW of approved power generation schemes of which 10.17 GW were in operation and balance schemes of 16.0 GW aggregate capacity were in various stages of implementation. Since then, the aggregate capacity approved has increased to 27 GW of which 23 GW is targeted to go into operation by the end of 1973-74. There is a paucity of fully investigated schemes and also a general unpreparedness on the part of the States in respect of their future programmes and advance action thereon. While the States themselves indicate large potential demands in their areas in the Annual Electric Power Surveys, the activity required for fulfilling these demands remains far behind the requirement. In the 'Guide Lines' issued for the formulation of the Annual Plan 1971-72, the States have been desired to devote their attention to this aspect.

4. Presently, a skeleton power plan (for power generation only) for the Fifth Five-Year Plan is under preparation in the Central Wate and Power Commission. This plan, it is understood, is being based on a target of 42 GW installed capacity target for 1978-79 and would include schemes on which investigations have been completed or are in advanced stages of completion. It may still take considerable time for the exact target for 1978-79 to be determined as this involves examination and discussions between the States and the concerned Central Ministries and Planning Commission. Pending this, it is suggested that the work should be authorised on additional schemes immediately so as to enable achieving at least 80-90% of the above estimated figures of 42 GW in the Fifth Plan. The position should be reviewed thereafter periodically and further schemes sanctioned on the basis of the target that may be finally fixed.

5. In the Conference of the Chairman of State Electricity Boards held in April, 1970, these matters came up for consideration.

5.1. It was agreed that advance action would be taken on the preparation of project reports for schemes to be taken up for benefits during the Fifth Plan period and that investigations would be taken up on such projects so that the project reports and feasibility studies could be completed.

5.2. It was further agreed that potential hydro power development sites would be selected for survey and investigations as this would facilitate efficient planning and implementation of power generation schemes and would also provide employment opportunities to engineers.

5.3. Urgent action on the part of all concerned is now necessary in this behalf.

6. In the past, the projects have taken long for technical examination at the Centre and clearances from the Planning Commission etc. This has been mainly on account of inadequate preliminary investigations and the protracted correspondence that has resulted from it. The Planning Commission/CWPC have already drawn up the drill that is required in the preliminary investigations of projects etc. but these are not correctly followed. These happenings are mainly due to the anxiety of the project authorities to have the same approved for implementation quickly. It is clear that these difficulties will vanish if the planning is made on a nation-wide basis and a long range view is taken. For this purpose, the following is recommended :—

6.1. Each Electricity Board should have a planning cell which will be capable of taking into account the long range needs for electric energy as well as utilisation of the resources in the best possible manner.

6.2. Similar long range planning cells should also be organised in the regional electricity boards in order to make the planning wider based and utilising the sources of energy in the best manner possible. These should be able to coordinate

and correlate the plans prepared by the State Cells. The projections of the Annual Power Survey must be taken into account in addition to the working of the regional electricity grid on integrated basis.

6.3. At the Centre, the Planning Commission and CWPC should keep in constant touch with the work of these planning cells at the regional and State levels and a long-term power plan should be evolved without any delay. A long-term perspective (say about 30 years or so) should be evolved in addition to a long range plan for say the next 15 years based on actual power projects, thermal, nuclear or hydro. The projects should be identified in respect of geographical locations, power potentials and the time when they are required to be commissioned for meeting the needs of the region. The needs of the transmission network must also be identified and spelt out.

7. The above 15-year plans should be updated and extended every year so that the perspective power development picture in the next 15 years is always available to all concerned at any time. It would be advantageous to keep CWPC continually informed about the investigations so that suggestion of CWPC, if any, can be taken into account before the investigations are completed and before the feasibility report is prepared. This will also facilitate speedy examination of the projects. Organisational requirements for such investigation and subsequent execution should also be drafted well in advance. Study Group-3 has also considered this matter at some length and has come to the conclusion that "the overall responsibility for planning for power including investigations and processing of schemes right upto the point of initiation of construction should be centralised clearly as required by existing legislation with the Central Electricity Authority." The CWPC has been carrying some of these responsibilities on a *de facto* basis. The CWPC(PW) or the units thereof which are engaged on such work could be transferred to the CEA, so that it can get started well in this work. CWPC/CEA will have to be organised suitably for the above and also for checking estimates in a thorough manner to see that these are realistic. Modern computer techniques greatly facilitate planning studies involving voluminous date. A degree of precision unthinking earlier, can thus be attained. Adequate attention should, therefore, be paid to develop and adopt these techniques and make optimum use of their possibilities (Appendix-4).

8. Another matter pointed out by the Study Group-3 which also requires attention is the need for recognising that there would be certain areas of the country such as the Indus Valley, Ghagra Valley, Godavary Basin etc., where the number and magnitude of power schemes, their geographical locations etc. are such that the normal arrangements for project planning, investigation and execution through the State Electricity Boards may not be adequate. In such cases, separate River Valley Authorities may be a better solution both for conducting the investigations in their respective valleys and for executing the projects as these schemes find a place in the overall long-term National plan.

9. In view of the increased tempo of activity that is bound to occur in almost all the State Electricity Boards on account of the large programme of investigations, planning and construction, there is an urgent need for strengthening the civil engineering organisation in each of the Boards. An experienced Chief Engineer (Civil) should be appointed in each Board. Among other things he should be in overall charge of a full time planning and investigation circle which will carry out the detailed field investigations as well as prepare the preliminary designs and estimates particularly of the civil engineering works. Depending on the work load, the Chief Engineer should also have under him other circles for maintenance and operation of the civil works of the hydro and thermal projects as well as for civil construction works of new projects.

10.1. The long range planning of generating capacity and an integrated region-wise view of the needs of future growth of power generation would have the additional benefit of enabling the economies of scale to be availed of, particularly in large steam power plants. The increasingly larger sizes of generating units enable substantial reductions in the initial cost (per kW) of installation and also enable reduction in the operating cost by increase in power plant efficiencies as well as due to economies of scale in the matter of fuel transport and handling, O&M costs, etc. The largest size of generating unit that can be conveniently accepted on a power system is limited by the total installed capacity of the power system and region-wise approach, therefore, would be beneficial. This subject has been discussed in the reports of Study Groups 2 and 3 in some detail.

10.2. The largest size of steam generating unit presently installed is 150 MW and the nuclear power plant at Tarapur as well as those under construction have generator ratings of the order of 200 MW. In the present schedule of manufacture of M/s. HE & BHE, the largest unit is rated at 120 MW and it is expected that 200 MW would also be included in the manufacturing programme shortly. These manufacturing programmes take considerable time to mature and make indigenously made generating units available. Taking this development period into account, it is felt that the question of deciding the next larger generating unit rating and the year in which these should be brought into operation should be examined carefully by the CWPC who should take the views of the users and manufacturers into account.

The type of investigations required in planning of steam power stations are outlined in Appendix-10.

7. INVESTIGATION

1. The resources of the country on the energy map are spread out in different geographical regions. These are comprised of water power resources; fossil fuel resources and nuclear fuel. In order that these resources are efficiently harnessed to meet the power requirements, it is necessary to have a proper idea and listing of the likely resources. A great deal of investigation is required to assess these resources. For hydro, detailed survey in the field of hydrology as well as geology, storage sites, geographical surveys are required, apart from the transmission line surveys, In the matter of fossil fuel, the availability of coal, type of coal, quantity of cooling water etc. are also to be investigated in detail, apart from the transmission line surveys. The hydro sites are rigid in a sense that they are dictated by the geography of the place but in regard to fossil fuel energy, it can be argued that the generating stations could be located at the consuming centres, which may be far removed from the sources of fuel. It is, therefore, necessary to properly assess the economics of carrying the fuel by rail to the consuming centres or alternatively, to generate power at the fuel sources themselves. In this regard, looking to the size of the generating stations which are going to be installed, the choice is distinctly in favour of locating the generating stations at the sources of fuel, provided adequate capacity of cooling water is available. Where water is not available, investigations will be required to be carried out to see how best the cooling water could be supplied. Nuclear power plants could be considered for being located near the consuming centres. The fact of these being nuclear stations and the large water requirements as well as special safety and security requirements will influence the location in a large measure.

2. All above will require continuous field investigation and will be necessary for the formulation of the long-term perspective plan recommended in the previous Section. Irrespective of the requirements of power of a State Electricity Board at any point of time, these investigations should be carried out continuously for identifying prospective sites and establishing their potentialities for different levels of development and possibilities of stage development. These investigations must be taken up by the State Electricity Boards immediately. Where inter-State development of a resource is indicated, the Regional Electricity Boards should take up the work. Formation of a Rivery Valley Authority may also be found desirable in some special cases and this can be brought in at an appropriate time to take the responsibility for further detailed project investigations and subsequent execution of individual schemes in the River Valley according to a time table prescribed by the perspective plan. The CEA, if made effective, could get this work done. The CWPC should be kept in close and continuous touch with these investigations so that these proceed on fruitful lines technically. This first stage of investigations for project identification should normally be done well in advance and should form the basis of including the projects in the 15 year rolling plan. Additionally at the current juncture, a massive programme of investigations will also have to be undertaken for making available adequate schemes of power generation for the requirements of Fifth and Sixth Plans. The present states of investigations in hand for projects to be implemented in the 5th and 6th Plans is given in Appendix-5. These investigations should now cover the 2nd stage outlined below also.

3. The second stage of investigations would comprise very exhaustive and detailed investigations about 10—12 years in advance of the time when the benefits from the project are required. These field investigations as well as preliminary designs would aim at establishing the different physical features of the project in sufficient detail for preparation of a comprehensive project report and estimates. These investigations and surveys would include topographical as well as geological and meteorological investigations, mapping out of the project sites for the main components of the project, preliminary designs and proposals for facilities of access, communications, colonies, water diversion storage and water conductor system for hydro projects, fuel and water availability for thermal projects and so on. The proposals for construction methods, construction plant and equipment (lay out as well as requirements) will also have to be worked out. The manner in which the project fits in the existing power system and the requirements of additional transmission and other facilities would also have to be studied and worked out. Guidelines and check-lists have already been prepared by Planning Commission/ CWPC for preparation of project feasibility reports. The investigations at this stage would have to be adequate to satisfy the requirements of these fully. For carrying out these detailed investigations and surveys, it is recommended that each Electricity Board or the State Government should have one or more well organised Survey and Investigation units including a geological unit along with the necessary equipment required for this work. The Project Design and Engineering Organisation or the Consultants, if appointed, would need to be closely associated with these investigations so that the preliminary designs and estimates forming the basis of the feasibility report are fully realistic. Specialised facilities available in CWPRS, Poona, CSMRS, New Delhi or other Design and Research Institutions should also be fully availed of.

3.1. The survey and investigation unit, suggested in the previous paragraph, could also be under the civil planning and investigation circle. In the light of the past experience, the need for a close co-operation from the beginning between the project planning and design groups and the field in-

vestigation units cannot be overstressed. Time and again it has been found that costly and time consuming field investigations have failed to yield adequate data for project design estimation and execution on account of the investigations being carried out in isolation from the design groups. Keeping the design engineers in the picture, from the beginning by discussions and periodic visits to site has always proved very valuable in ensuring proper orientation of the investigations and avoiding unnecessary efforts.

4. The finances for such investigations could be provided in the initial stages as "on account grants" which will be in the nature of promotional expenses. Large funds would be needed for this work but when the particular project is accepted for execution, then the amount incurred for that particular project, may be debited to that project and the "on account" payment reimbursed so that revolving funds would be continuously available for investigation purposes.

5. When the project is sanctioned and taken up for execution, further field investigation work is required to meet the needs of detailed designs and construction drawings These investigations are a part of the execution of the project and are required to ensure a maximum economy of time and cost in the project construction. These investigations would be required even for the the Project Report. It may be mentioned here normal execution of the project as visualised in that some of the investigations (particularly meteorological and hydrological) initiated during the second stage mentioned above for purposes of formulation of the project must be continued uninterrupted and, in fact, instituted on a semi-permanent basis.

6. Non-availability of access facilities has proved to be a severe handicap in the preliminary as well as detailed investigations of hydro-electric projects as also in achieving an accelerated construction schedule. The requirements, of course, vary at the different stages. Initially, access tracks or jeepable roads are enough for carrying surveying and drilling equipment etc. while, in later stages, pucca roads capable of enabling transport of heavy construction machinery and plant and equipment are required. These roads also serve to open up the remote inaccessible areas of the country and bring other economic benefits. When the feasibility of a project is established, construction of minimum road communications should be taken up from the investigation fund. If necessary, an appropriate proportion of this cost can later be charged to the project. This will greatly facilitate thorough and detailed investigations. Later, as soon as, the project is sanctioned, the construction of all the access roads should be undertaken and completed. This will expedite the execution and completion of the project. The expenditure in the latter case can be charged directly to the project estimates.

---

8. PROJECT PREPARATION

1. The preliminary project report would suggest but broad features of the project and capabilities of the site to be developed. This would include the basic hydrology, feasibility of structures like dams, tunnels etc., availability of cooling water or fuel in the case of thermal power stations and so on. This will have to be in sufficient detail to establish acceptability of the project for further work but would be far short of the detailed and exhaustive investigations required before a detailed project report and estimates to form basis of project execution can be prepared. The latter investigations will have to be taken close to the time when the project is likely to be taken in hand for construction. This is desirable as it will enable the substantial expenditure involved in detailed and exhaustive investigations to be deferred as much as possible and also enable the designs and estimates to be based on actual ruling costs and latest available construction techniques.

2. The Planning Commission in consultation with Ministry of Irrigation and Power and the Central Water and Power Commission have already circulated a model proforma for the preparation of the project reports. This may be brought uptodate and circulated again. This proforma is a comprehensive one and should be followed rather strictly. It is of course true that power projects seeking to derive optimum benefits at any location will have their peculiarities. It is, therefore, possible that at the time of preparation of the project report some improvements in the model proforma may suggest themselves. These may be brought to the notice of the Planning Commission and CWPC so that they can review and improve the model proforma in the light of the experience gained. Preparation of the project report in accordance with the model proforma will obviate the necessity of protracted correspondence and resultant delays in sanctioning of the projects.

3. The time schedule for execution of a power project should be realistic and should include the time taken for investigation, preparation of the project and feasibility reports clearances and approvals of concerned authorities etc. The following time table would be practicable :

Preparation of feasibility report	8 months.
Approval of the concerned State authorities	2 months.
Examination/clearance by CWPC and Planning Commission	6 months.

4. With the present inavailability of properly investigated projects for sanction and the need for undertaking a large number of projects all over the country to meet the power requirements, it will be necessary to strengthen the technical examination units of the CWPC very considerably so that the heavy work load can be handled by them competently and efficiently and within the above time table.

5. The above period of 18 months makes the project ready for execution. With the advance planning already indicated above, the planning regarding the manufacturing capacity for the main items of equipment such as boilers and Turbo-generator sets can proceed simultaneously and while giving the approval the Planning Commission can indicate the preferred suppliers for the main items of equipment.

9. FINANCING

1. After the sanction of the Planning Commission and that of the concerned State authorities is obtained, it is necessary to prepare not only the year-wise construction programme but also a programme for financing and incurring the expenditure. The latter actually dictates the pace of the former. It becomes necessary to provide the required finances including foreign exchange for the construction programme as per schedule. It is often found that projects are sanctioned by the Planning Commission but the required finance year by year is not forthcoming, resulting in faltering construction, leading to the delays in the actual commissioning. Similarly, manufacturing programme is also not kept up because of non-payment of money as per delivery schedules. In order that the Project Authorities can plan the construction programme according to the Plan schedule, the finances should be made available as per the phased requirements of the project. This will go a long way in the completion of the project as per schedule. Koyna (Stage 3), Nasik and Koradi are cases in point where projects have suffered.

2. One of the reasons for paucity of funds in the course of construction of projects is that the project construction takes a number of years. In the course of these, various new matters arise and the relative priorities for different projects often change in the eyes of the State Governments. Funds sanctioned for one or other aspect of a power project have sometimes been diverted to other purposes. This vitiates proper balanced Plan progress. In the present structure of financing where Central grants/loans are also provided for power projects, such diversion of funds could be discouraged thoroughly by the Planning Commission "earmarking" the funds for specific projects at the time of formulation of plant provisions. (This means that in case of any diversion of funds by a State to some other purposes, the State loses the Central grants for the project.) This earmarking of funds by the planning Commission is strongly recommended so as to obviate slowing down of projects and consequent steep rise in the project costs and delay in their benefits due to inadequacy of funds for project execution.

3. Presently, the State Electricity Boards are borrowing large sums from banks and finance institutions like the LIC at rates much higher than the interest charged by State Government. Such rates should, therefore, be taken in the project reports in working out the financial implications.

4. At this juncture, one rather disturbing fact has also to be considered. While projects have often suffered from paucity of funds due to their diversion to other purposes the overall picture in the country is one of non-achievement of targets despite full provision of estimated requirements of funds. In this connection Table-6 based on the records of the Planning Commission may be seen. The actual spending in the past plans has been far in excess of the provisions asked for sometimes as high as 30%. At the same time, the achievement of physical targets has slipped back by as much as 25% or more in many cases. Thus, paucity of funds has inhibited the progress of projects in many cases only in the sense that it has not been possible to execute these projects within the cost estimated originally. The performance in this respect has been different in the different sections of power projects. In the case of rural electrification, the excess expenditure over the plan provision is largely accounted for by the higher physical achievements actually made.

4.1. In the case of generation and transmission, however, there has been a great deal of excess expenditure as well as slippages in achievements of targets. This is on account of two main reasons :

(i) Under-estimation of cost at the time of preparation and sanction of the project report; and

(ii) Rising cost of materials, labour and other services like transport, etc. in the course of project execution.

4.2. The under-estimation of cost can mostly be traced to inadequate investigations, designs and engineering and due to imcomplete information on anticipated costs and rates. It is also sometimes part of wishful thinking on the part of

project authorities in their anxiety to make the project attractive. The rising costs is now a common feature not only in India but all over the world and it is the practice of some of the leading consultants in other parts of the world to provide for the rise in costs by provision of a definite margin in the project estimates. Delay in project execution greatly increases the project cost on this account. The delays have the further effect of substantially increasing the cumulated interest on investments prior to deriving any benefits and this, coupled with the delay in revenue earning, seriously affects the economics of the project. This experience in the past highlights the dire necessity of having realistic estimates of the time and cost of project execution based on thorough and detailed investigations.

4.3. In view of the importance of this matter it is in the interest of all concerned at the State as well as Central level that the cost estimates and time schedules are prepared on realistic basis and checked thoroughly. Presently, these are scrutinised as part of the technical examination of the projects by the Central Water and Power Commission before these projects can be processed through the Technical Advisory Committee of the Planning Commission for approval. It is strongly recommended that the CW&PC should be charged with thorough scrutiny and a measure of responsibility for the accuracy of the estimates of the time and cost of project execution. It is true that the rates of wages and basic materials of construction keep on changing. However, with thoroughly investigated projects it should be possible for CW&PC to check and ensure that the basic designs of the different components of the project as well as the type and manner of construction, construction plant and equipment and quantities of work involved are correctly provided for. The CW&PC should organise and equip itself for such work without any delay.

---

10. PROCUREMENT

1. It is common experience that procurement procedures affect the construction programme seriously. The Committee on Shortfall in Third Plan has already considered these matters in detail and have observed that the procurement procedures have seriously affected the construction programme and hampered construction progress in many vital projects. They have also gone into the utilisation of agencies such as the DGS&D and the part played by the Chief Controller of Imports and Exports. The conclusions arrived at by the Shortfall Committee continue to be valid even now. However, there has been one important change in the situation since then. A major portion of the plant and equipment for the power projects is now available from indigenous sources.

2. So far the turbo sets (both thermal and hydro) have been planned on either M/s. HE or M/s. BHE according to the manufacturing capacity available, delivery dates, ready availability of designs, etc. This practice has been quite satisfactory. In this way, the manufacturing capacity can be loaded in an even manner and since competitive bidding and discussions are not necessary, the time and effort required for drawing the plant specifications in a manner permissive of the practices of both the manufactures and the consequent discussions, etc. are all eliminated. While giving the approval to the project, the Planning Commission would indicate the preferred suppliers for the T.G. sets and the orders can thus be placed very quickly—say in a matter of two months or so. In some recent cases, these two manufacturing units have been found to be entering into competition with each other for new orders. If this trend becomes general, it would become necessary for the project authorities to write fairly detailed specifications for the turbo generator sets and to go through considerable formalities, discussions, etc., which would be costly both in time and effort. Healthy competition may be desirable for advancement of these manufacturing units in the distant future. However, presently, manufacturing capacity available in both the manufacturing units together is not sufficient to meet the requirement of the country fully.There is, therefore, no need for competitive bidding between them and their energies should not be diverted for this purpose but should be concentrated on improving and expanding their manufacturing capacities.

2.1. As regards purchase specifications, the CBI&P Working Group on "Standardisation and Variety reduction in Hydroelectric plant" has already done considerable work and framed typical specifications for each type of hydraulic turbogenerator set based on each of the technologies adopted by M/s HE and M/s. BHEL. Adoption of these will yield considerable saving of time and effort and unnecessary discussions/ negotiations will be eliminated.

3. It is suggested that the Ministry of Irrigation and Power should ensure that there is a smooth flow of orders suiting the capacities and stage of development of the two manufacturing units form time to time. The Ministry should plan the major items of plant and equipment for each project suitably on these manufacturing units, taking into account the requirement of the project in respect of similar units, schedule of construction, etc. It is possible to secure overall economic advantage by grouping orders placed on the two manufacturing units rationally so as to obtain optimum benefits from development

and design. The matter is complex and requires a cautious and informed approach. It is desirable to take this aspect into account while planning orders, preferably in consultation with the CWPC who would be in touch with the overall plan and programmes of projects, manufacturers etc. The Ministry of Irrigation and Power should also assess the manufacturing capacity of M/s. Heavy Electricals and M/s. Bharat Heavy Electricals from time to time for deciding upon the range and quantum of equipment still required to be imported year by year for maintaining the programme of power development.

4. The delays on account of formalities and procedures of CCI&E and those involved in tied credit, World Bank loans etc. for getting foreign exchange release are thus virtually eliminated so far as the main power plant is concerned. The generating units to be supplied by indigenous manufacturers are a monopoly of M/s. HE and M/s. BHE and usually the price has to be negotiated with the suppliers. The Government of India have already set up a Committee for this purpose. All concerned should, however, agree to ensure that the deliveries of the generating equipment should not be affected on this score. Firm deliveries should count from the date of the letter of intent issued to the manufacturer after finalising the broad technical particulars (preliminary project report as M/s. BHE call it) with them. Finalisation of the contract agreement, prices, advance payment, etc. should take place during the pendency of the deliveries and not affect in any way the committed delivery on this account.

5. *Performance Specifications.*—As the manufacture of equipment is proposed to be assigned to the two units M/s. HE and BHE through advance planning, and there is to be no competitive bidding, the requirements regarding efficiency and output guarantees lose their purpose of forming an incentive for achieving better performance through competition. It is therefore imperative to devise a mechanism whereby it can be ensured that the manufacturing units will strive towards attaining highest possible efficiencies and producing increasingly superior machines. The manufacturers must offer increasingly better performance figures according to the world trends. A standing Committee comprised of representatives of both the manufacturers, CW&PC and one academician should be set up to decide the performance figures and to coordinate the action in this regard. Early setting up of such a Committee is an urgent necessity.

6. Apart from this, a new element has come in the comprehensiveness of procurement action on account of supply of generating units from M/s. H.E. & M/s. B.H.E. They supply equipment as per the standard practice of their collaborators. As a result of this, some of the essential auxiliaries/equipment of generating plant are not included in their offer. The extent of such items can presently be known only after the receipt of the detailed schedules of supply for the generating units from the manufacturers. This is very unsatisfactory and considerable amount of avoidable confusion and hardship is caused in the work of the project authorities. It is, therefore, recommended that both M/s. H.E. & M/s. B.H.E. should be asked to make their quotations thorough and businesslike from the beginning by furnishing detailed lists of all equipment and accessories that they would be in a position to supply and the balance equipment that the project is expected to procure from elsewhere. Further, the quotation for the entire scope of supply of these manufacturers should be binding, although they will continue to include a number of bought out items in future also in keeping with the general practice all over the world. As it is, they go on varying prices and deliveries for bought out items included in their scope of supply. It may be mentioned that bought out items include important basic components like cylinders of steam turbines. It is general accepted commercial practice all over the world for the manufacturers to give a firm quotation for their entire scope of supply and adoption of this as well as proper definition of the scope of supply would eliminate many avoidable controversies and delays in engineering.

7. As regards other items of electrical and mechanical plant such as, transformers, circuit breakers, etc., there is no monopoly in the indigenous supply. The Project Authorities can advantageously arrange procurement of the balance plant and equipment on their own instead of going through the Director General of Supplies and Disposals (DGS&D). In regard to certain items, advantage can also be taken of the rate contract arrangements made by the DGS&D.

8. Good many items of plant and their ancillaries and other items have been standardised; therefore, while preparing specifications for such items, choice as far as possible should be only of the standard articles rather than non-standard ones. This will help in reducing the time of procurement and also result in economies :

9. Tender specifications should be drawn up with as many details as possible and should include listing of all the information, such as technical data, requirement of firm deliveries, contractual and financial requirements, etc. required of a tenderer. If the specifications themselves are not complete, there is a lot of confusion and some tenderers could get undue advantage. It is also difficult to reject the unwanted tenders if the desired performance guarantees have not been specifically asked for in the specifications. A good and complete specification will, therefore, reduce to the minimum post tender/contract correspondence and meetings with the tenderers. Claims for extras by the contractors which usually stall the execution and deliveries and servicing of the contracts is smooth and trouble-free. This will also enable the field staff to have a proper specification document on the

basis of design details. Broad specifications for most of these items should be made as soon as general idea regarding the size and type of generating unit and power house is known. Details of specifications in many cases are dependent on the finalisation of the technical particulars of the main units. Crane specifications, for example, have necessarily to depend on the requirements of the generating units and station layout. Thus, if broad specifications are made in advance, final specifications for these equipment will not take undue time. Time available for procurement for these is short. Therefore, these items, howsoever small, can hold up the commissioning of the generating units. There are instances when, say, the crane deliveries had to be advanced by payment of fantastic amounts as the power house commissioning was dependent on crane delivery and large loss of revenue was involved.

10. At the time of invitation of tenders, sufficient time should be allowed to enable the tenderers to furnish all the technical and financial particulars. Thereafter, the validity time should also be long enough to enable detailed examination of the tenders and arriving at a decision within the validity period. It is necessary to draw out a time table of all tenders which are to be invited, showing therein the time required (i) for preparing tenders; (ii) for receipt of tenders; (iii) for examination of the tender leading to the recommendations; (iv) for approval by the competent authority for placement of order and (v) for the actual issue of the letter of intent. These timings should be brought out for all major items of tender.

11. The examination and acceptance of tenders must be completed within the validity period and occasions for extension of validity should be only exceptional. In a number of cases, tenders are reinvited. This may be due to various causes some of which may be insufficiency of technical data in the tender specifications, variation in the scope of supply as well as the type design by the suppliers. If the tender specifications are written up in good detail by taking adequate time in early stages, much labour, time and confusion would be avoided in the subsequent stages. The extension of validity or reinvitation of tenders often results in manipulation of prices. Considering the interest of the project as a whole and the time and labour lost, it is not a desirable thing either to ask for extension of validity or to go in for retendering.

12. One of the main reasons for delay in placing orders for the equipment is the time taken to reconcile the commercial terms with those specified in tender specifications. A model "general conditions of contract" applicable to public and, if possible, to Private Sector manufacturers, binding on all the parties, would go a long way to reduce the time between the receipt of the tenders and placing the orders. The main features of this model "general conditions of contract" should be (a) firm price or CPA (with a limit, if any) throughout the execution of the order. It would, however, be preferable to avoid CPA altogether; (b) delivery and force majoure terms should be properly defined. Delivery penalties should be rigid; (c) In order to ensure timely receipt of designs/loading data, a specific amount of payment should be set aside and paid on receipt of above information; "general conditions of contract"; (d) warranty should be at least for 30 months from the last despatch (36 months for boilers) or 12 months after commissioning for all items. Presently, manufacturers are quoting only 18 months from the last despatch. This is inadequate for a thermal plant, whose erection takes over 18 months; (e) tenders should include a programme for manufacture to justify delivery period quoted and this programme should be binding. Monthly or bi-monthly progress report should be a part of the contract terms.

13. When there is insufficient information either on technical particulars or on financial items or the tenderer mentions some of his own terms and conditions not in keeping with those specified, it becomes necessary to invite the tenderer for discussion. For such a purpose, it is suggested that only a limited number of parties who are likely to obtain the order, need be invited, and they should be given a specific time limit with in which to complete the missing information and decision should be taken thereafter.

14. While examining the tenders, due consideration should be given to ensure that the tenderers are in a position to meet the requirements technically, financially and within time. It is important that all the necessary formalities and procedures for such examination are well set and understood by all concerned.

15. The discussion and recommendations in the Section on Construction Contracts are applicable to supply contracts also to a large extent. These may also be adopted suitably.

11. MANUFACTURE OF EQUIPMENT

1. The maior items of generating plant and equipment are now to be supplied entirely by the public sector undertakings, viz. M/s. H.E. and M/s. BHE, These have been facing some teething troubles in the past few years, but the management of these undertakings now claim that the troubles have been largely overcome and that they would be in a position to main-

tain the promised delivery periods. Actually, however, they are contributing substantially to the delays in project execution. Tables 3 and 4 give a comprehensive survey of the position in this respect in the case of M/s. Heavy Electricals and M/s. Bharat Heavy Electricals respectively for both hydro as well as thermal power plants. This is causing serious difficulties in achieving the targets set for installed capacity for the coming Plan. This was also considered in the Fourth Conference of the Chairmen of State Electricity Boards (vide Appendix-I, Item-2). As resolved in the Conference, the Ministry of I.&P. have recently set up a Committee to examine the capacity of these manufacturing industries to supply the generating plants in time.

2. Many factors are inter-linked in ensuring timely delivery by the manufacturers such as timely availability of imported raw materials, quick exchange of technical know-how with the collaborators, timely bought out indigenous and imported items, shop floor capacity and proper production planning. Periodical visits by the purchasers' representatives to the factories can be helpful in proper assessment of the work in progress and in some cases the purchasers could also be of assistance to the manufacturers in sorting out some of the problems. For example, although the plant and equipment is manufactured indigenously, some items of equipment and raw-material would need to be imported. The manufacturer should indicate his need of foreign exchange (source as well as amount) at the time of accepting the order. This should be taken into account and the Ministries of I.&P. and Industrial Development should ensure that this foreign exchange is sanctioned and released without any undue delay. The Project Authorities should also expedite the concerned authorities to see that this is done within a reasonable time from placing of the order.

3. The manufacturers should also indicate all other factors and assumptions on which their promise of delivery periods is based. In fact, it would be desirable as contractual obligation for the manufacturers of different major items to furnish the project authorities with their PERT network chart for items of their supply including exchange of drawings and data with the purchaser so that the various activities necessary for achieving timely supply of equipment can be undertaken by all concerned. This will also enable the project authorities to follow the progress of manufacturing intelligently for taking timely follow-up action as well as for readjusting the construction schedules where necessary.

4. With the establishment of indigenous manufacture of the main items of plant and equipment, it would be possible to transport the manufactured items to the project sites mostly by rail or by special trailor tractor units. Under the circumstances, the manufacturers should pay special attention to reduce the erection work at site to a minimum by adopting shop assemblies in as large a measure as possible. With the special machinery and skills available in the factory compared to the site, this would lead to substantial economies in time as well as costs of installation of the plant and equipment. Adoption of larger shop assemblies would evidently be restricted by the limitations of transport and transhipment. For this purpose, it is recommended that the manufacturers should examine the various items carefully and devise special wagons/transporters for making the best possible use of the rail and road routes in the country.

5. *High Level Co-ordination Board.*—The CBI&P Symposium in November, 1965 had recommended the setting up of a high level Co-ordination Board for the manufacture of power plant and equipment. It is recommended that this Board, *inter alia* should also be entrusted with the responsibility of assigning priorities and programmes for the manufacture of equipment for various projects in consultation with the concerned Central and State Authorities after careful consideration of financial administrative and other factors involved. Such a considered and detailed planning would help in avoidance of frequent changes in programmes which have taken place in many instances, resulting in upset of manufacturing schedules, and would avoid consequential delays and wastage of effort. Immediate formation of such a Board is necessary.

6. The Working Group on Hydro-electric plant and equipment set up at the above Symposium had considered that there is a great deal of scope for rationalisation of the manufacture of automatic voltage regulator and excitation equipment as well as governors for hydro-electric turbines. A considerable scope exists for standardisation and availing of economies of large scale production of a few standard designs in the case of these items of equipment. Very little, however, appears to have been done in the intervening years. Rationalisation of the manufacture of these items by consultations among M/s HE, M/s BHE and CWPC would offer substantial economies in the purchase of advance technologies as well as manufacture of these items.

6.1. Similarly, M/s. HE and M/s. BHE are both equally well-equipped for manufacturing the turbine inlet valves (for hydraulic turbines). As already recommended by the Working Group, joint planning may be done by both these manufacturers so that duplication of efforts on these items is eliminated.

12. TRANSPORT FACILITIES

These can present severe bottlenecks. The requirements are two-folds.

1. Firstly, large quantities of materials and equipment have to flow to the project site smoothly as per project requirements during the construction period. Proper arrangements for road and rail transport, arrangements for transshipments etc. have to be made. It is important to do advance planning and programming of shipments and to establish proper liaison with the railways. In the case of large steam power stations permanent railway siding facilities are required as a part of the power station installation for handling shipments of fuel. It is strongly recommended that this railway siding should be constructed as early as possible so that it could be utilised for requirements of the construction project, thus reducing the construction cost to some extent.

2. Secondly, there are special problems of unusually bulky or heavy packages. Very careful advance planning is required for these A survey of alternate routes or methods of transport should be made as early as possible when such packages are identified in the course of design. Some organsations like Damodar Valley Corporation, the Atomic Power Authority posses special transporters. Certain State organisations have special tractor-trailer units for difficult mountain roads. It is recommended that the Designs Organisation of CWPC should survey and catalogue such special equipment so that the different projects can draw upon it when in need. Considering the increasingly larger sizes of generating units and other equipment, the special transport equipment presently available will not meet all future needs. The CWPC in consultation with M/s. HE and M/s. BHE, should take up the matter with the Railways for design and, construction of special wagons, mobile cranes and with the Regional Electricity Boards, for special road transport. The experience in U.K. in this respect may be of interest. The report of CEGB for 1967-68 states :

> "93. The heavy load vessels "Aberthaw Fisher" and "Kingsnorth Fisher" continued to operate successfully, making 41 and 38 voyages respectively and carrying a total of 91 abnormal loads. The air cushion vehicle (ACE) carried two further loads over bridges which would otherwise have needed strengthening at an estimated cost of £60,000. The forward programme for the heavy load vessels and for the ACE includes the movement of large units for export which otherwise could not have been built and shipped from this country."

---

13. SHORTAGES AND BREAKAGES IN EQUIPMENT

1. A certain measure of breakages as well as shortages during transit, storage and erection is inevitable. Usually, this is covered by insurance so far as the monetary cost of these is concerned. However, this often introduces one more cause for delay. Whenever any shortages or breakages are revealed, the present procedure for recouping the damage is to have the necessary survey carried out by the surveyor of the Insurance Co. and to ask the supplier to quote the price for replacement parts after obtaining the certificate from the surveyor. Delays occur due to (i) an Insurance Surveyor not reporting promptly; (ii) ordering of the replacement parts being delayed so that the replacement is not available when required for erection and (iii) the supplier's delaying quotation of a price or increasing the price with the result that the process of reordering has to be repeated.

2. In the light of the past experience, it is suggested that the Project Manager should have the damage or shortage inspected on his own and should proceed with ordering of the replacement. The process for making the insurance claim and the necessary inspection etc. therefor can proceed separately simultaneously, but the matter of ordering the replacement should be initiated immediately after the damage or shortage comes to notice, without waiting for acceptance of the claim by the Insurance Co. If, for this purpose, fresh foreign exchange is required to be released, the Government of India should not hesitate to do so. In a number of projects, considerable delays have occurred in the past in commissioning of generating units in this manner and it is important that this does not happen in future for want of a small amount of foreign exchange.

---

14. CONSTRUCTION EQUIPMENT AND PLANT

1. One of the major causes for delays in the execution of projects is inadequacy of proper construction plant and equipment. It is, therefore, essential that the procurement of construction equipment and plant should be initiated well before the start of the execution of the project.

2. *Extent of mechanisation.*—The Engineer in overall charge of the project or the Project Manager should decide the extent of mechanisation at design/planning stage. There are many factors which have to be taken into consideration in deciding the extent of mechanisation. Certain items of work are best done by manual labour with the help of a few simple machines. Labour-intensive methods have to be preferred in view of the unemployment prevalent in the country. There is dearth of skilled workers whereas unskilled labour is available in abundance. The target set for completion of a particular project and the availability of Labour resources in a local area are also important. Large projects such as the dam and tunnels at Bhakra or earth-work at Hiraqud could not have been achieved without the use of modern machines. Then there are cer ·which are best done with the help of vation of foundations and tunnels, .. of large earth dams, rapid construction in short working seasons are matters in which mechanistation seems indispensable even in medium sized jobs. Extent of mechanisation should therefore be decided on considerations of economic execution of project, job opportunities to a maximum number of personnel and expeditious completion of the Project.

3. *Selection of construction equipment.*—It is necessary to have a minimum number of types of equipment and to select such types as will be suitable for a majority of the items of work. The selection of the construction equipment should be done by an engineer who has specialised knowledge of the characteristics of the types and makes of equipment with reference to their operation under the working conditions on a particular project. He should know how to interpret and modify the operational and performance data furnished by the various makers pment for realistic application to the litions. Many reference books on the selection are available and this aspect need not be dealt with elaborately here.

---

15. CONSTRUCTION CONTRACTS

From the viewpoint of the project, construction contracts involve three main steps—(i) contract preparation, (ii) selection and award of contract and (iii) execution of the contract. All the three steps are equally important for achieving satisfactory construction work. The integration of contract activities with the overall project plan forms the basis for effective project control during construction phase.

1. *Contract Preparation*

1.1. The ability to control a construction project, most elements of which are given on contract, depends largely on the soundness of the contract documents themselves. A loosely defined contract may create considerable dissensions between contractors and project management due to individual interpretations of the intent as well as contents of the contract. Disputes regarding advance payments and correct form of bank guarantee from the contractor have often delayed commencement of construction work. Similarly, serious delays have occurred in completion and acceptance of design drawings. The contracts usually specify certain exchange of drawings between the two parties and their mutual approvals. This is often treated lightly at the stage of drawing the contract when the nature and significance of these drawings is not properly foreseen. Extensive changes in the designs and drawings at a later stage naturally lead to dissensions—project cost rise and delays.

1.2. As mentioned earlier, it is also necessary to fit together the schedules of different independent or interlocking contracts. Application of PERT network techniques for this purpose is discussed elsewhere. The Project Authorities are not unaware of the need for contract schedules and all contracts include clauses emphasizing the importance of time element. However, the development of an overall project schedule specifying the broad outlines of the timing required of each major contract is usually left to a later date. The development of effective schedules for civil design, construction and equipment erection depends greatly on the delivery schedules for the major plant and equipment as well as supply of basic design and loading data regarding the plant and equipmem from the manufacturers. The development of a schedule that effectively binds the contractor is extremely difficult after the contract document is signed and the work has been started. In fact, negotiations in this regard are very difficult even after the letter of intent itself is issued. When asked to guarantee his schedule, the contractor in turn asks the project management for guarantees in respect of their part of the work (e.g. Guarantee, dates for securing import licence approval) which the project is unable to give. A detailed schedule for the contractor is, therefore, never contractually established. In fact, in some cases, the contractor would be tempted to establish a schedule which would confuse responsibility and suggest areas where the causes of slippage would be another party's responsibility. In such cases, it is not possible to invoke any penalty clause in the contract, if necessary, at a later date.

1.3. The only practical solution for this problem lies in developing the overall project schedule as well as the desired schedules for the

contract in qustion before inviting tenders and in any case before awarding the contract. Besides specifying the completion date of the contract, such schedules should define the required date for any significant point of communication or transfer of responsibility between the contractor and other participants on the project, for example, the dates for supply of design drawings, approval of contractor's drawings, assistance in respect of construction equipment etc.

1.4. In this procedure, it is also desirable to take into consideration the contractor's workload and difficulties. An opportunity should, therefore, be given to the contractor to suggest modifications in the schedule in his tender, preferably by submitting his proposed PERT network. The contractor can then be accommodated to the extent possible witnout affecting schedules of other works. One difficulty that would be encountered under the present circumstances in the country is prior establishment of the schedule for delivery of the major items of plant and equipment by the main suppliers. This point has already been discussed separately.

1.5. Even in a turn-key contract, it is recommended that the contractor should be asked to furnish at periodic intervals a status review report of his work together with an up-dated net-work.

1.6. The tender enquiry should require the contractor to submit details regarding his resources in men, materials and equipment that will be used in the contract.

1.7. It should also be obligatory for the contractor to inform the project authorities immediately whenever there is likely to be any change in his schedule.

1.8. Penalty and bonus clauses are very useful. Penalty clauses would be more effective if they are placed on every point of contract between a contractor and another party rather than merely specifying a penalty against the completion date of contract.

1.9. The design organisations should prepare and standardise a fairly elaborate classification of different items of civil works. Any contract for civil construction should be a package of known quantities of work of different classes estimated fairly closely at unit rates worked out in detail. Tenders can also be based on unit rates with overall lumpsum rebate for the whole package.

1.10. It will be apparent from the foregoing that the amount of pre-contract planning has a direct bearing on the speed and efficiency of the contract execution. Sufficient flexibility in the contract is also necessary to meet unforeseeable changes in circumstances. As the control and coordination that the project management can effect with the contractors depends directly on the actual contract document, it is essential that sufficient time and attention be allowed for the preparation of a contract document, which will ultimately bind all parties to a speedy and efficient execution of the work.

2. *Selection and award of contract*: Two main difficulties in this respect are—(i) the length of time taken administratively for scrutiny of tenders and decision and (ii) lack of clear information on the performance capability of various contractors.

2.1. Considerable delays have been experienced in scrutiny of tenders for each type of work. There is a need to evolve some system of compiling and evaluating information on the past performance of the likely contractors. The performance record of contractors should be a very important consideration in their selection. Acceptance of a bid other than the lowest can lead to criticism of the project authorities and, in such cases, the course of action needs to be documented thoroughly. Systematic documentation of information will help considerably in such cases. In addition to the overall performance, it is of course desirable to examine some of the details such as ability of the contractor's staff-supervisory, technical etc., prior experience on similar projects, availability of special tools and construction plant etc.

2.2. The Project Manager, responsible for execution of the Project should have the main say in selection of the contractors rather than the Minister, Secretary of the Ministry, etc.

2.3. Issue of the letter of intent to the contractor is often thought of as a short cut to getting the work started quickly. However, in actual practice, this often leads to a great deal of difficulties. Since specifications and contract terms are not closely established in a letter of intent, the project management have a minimum control over the contractor during the period till the contract is signed. Further, the contractor who receives a letter of intent can afford to be less flexible in final negotiation on contract specifications and this places the project management at a disadvantage. It is, therefore, highly advisable to draw up and sign the contract itself rather than issuing a letter of intent.

3. *Execution of the contract.*—As emphasized earlier, completion of a contract within time and cost objectives largely depends on the advance planning for the project and selection of the most suitable (rather than only the lowest) contractor. In addition, a certain amount of control needs to be exercised over the contractor. The project management should retain full authority under the terms of contract to request any measures that may be necessary for the proper and timely execution of the work. The project authorities control capability depends on the project information system and competence of their engineering organisation. The project personnel should constantly watch the progress and evaluate the effect of slippage on the part of any contractor on the rest of the project. This

evaluation should include economic analysis of the possible alternatives of corrective action. As in planning the construction work, servicing the contracts and supervision of contractors' work also the design and engineering organisation of the Project or the Electricity Board concerned has to play a very important part. It is, therefore, necessary to ensure adequate backing of a competent design and engineering organisation from the beginning. If this is not available from internal resources, there should be no hesitation in engaging appropriate consultanting engineers, say, the Specialised Engineering Organisation of CWPC or some firm of Consultants experienced in such work.

4. Recently, difficulties have arisen in arranging the execution of the complex generating plant and equipment through the equipment suppliers as in the past. Formerly, the suppliers used to be keen to have even a 'turn-key' job and were, in any case, prepared to carry out the complex erection and installation if equipment supplied by them. The supply of plant and equipment is now practically a monopoly of M/s. HE and BHE. They are, however, struggling with so many problems in manufacture of plant and equipment that they are neither equipped nor willing to undertake erection work of even their own equipment.

4.1. On the other hand, with the rapidly increasing tempo of new additions, each Electricity Board is likely to have certain amount of work regarding erection and commissioning of plant and equipment available at one project or another, continuously. It is, therefore, in the interests of the Electricity Boards to build up suitable teams that can undertake the work of installation and commissioning of plant and equipment, electrical transformers and switchgear and power plant auxiliaries. Building up such teams would also be of great value to the organisation in arranging overhaul and proper maintenance work and in case of any breakdowns. It would then be necessary only to have one or two persons from the manufacturers during the installation work in order to ensure that there is no difficulty with equipment guarantees.

4.2. Recently, some organisations in the private sector have been building up the expertise for undertaking erection and commissioning works. Their services can also be availed of.

4.3. Where enough sustained activity is expected, the departmental construction and erection work yields very substantial benefits. It is likely to be more economical and, being under the direct control of the project organisation, a first rate job can be obtained according to the exact specifications. Further, there is flexibility adjusting the work items to suit the overall commissioning schedule. On the other hand, if the jobs are given out on a number of major and minor contracts, the project organisation is relieved of considerable detailed work and some of the procurement and labour problems. If sustained activity is not likely to be available, then the departmental work would also involve further financial liability due to difficulties in retrenchment of personnel. Building up of expert organisation is also not possible under such circumstances. This makes it attractive to give the work on contracts, especially where suitable contractors are readily available.

5. As explained in the foregoing, the range of works covered by construction contracting is now being extended to cover erection of the complex plant and equipment and auxiliary systems of the power stations. The works now covered are quite different in complexity and the nature of activity from the simpler types of civil construction work formerly covered by construction contracts. This has led to difficulties regarding measurement or assessment of work done, contractual obligations and responsibilities of the contractor, as well as the project authorities, the equipment suppliers and others. A variety of problems are likely to arise as the construction work increases in volume, in the coming years. It is, therefore, necessary to establish a dialogue between all the concerned parties, particularly, the contractors and the project authorities. Since competitive bidding is the usual method of selection of contractors (and rightly so), it is not possible to have a free exchange of ideas between the contractors and the project authorities regarding the nature and contents of the contracts, responsibilities of the different parties concerned, nature of cooperation between them etc. at the time of award of contract. It is, therefore, suggested that the Institution of Engineers (India) or some similar body may be moved to bring together the contractor firms and project execution people to evolve a common understanding of the problems of this kind of work arising out of the changing situation and the preferred manner in which such works could be organised (e.g. standardised terms of contract etc.).

6. The accounting proforma and procedures currently used for these works are mostly those designed in the olden days for use with the simpler civil works, where the work can be measured in terms of physical dimensions. weights etc. These proformae are ill-suited for mechanical and electrical works involved in the construction of power projects involving increasingly complex Technology. It is suggested that the Ministry of I&P should appoint an expert committee of experienced design and construction engineers as well as audit and account officers with experience on power projects. The Committee should be asked to go into the methods, detailed rules and proformae and suggest changes that may be necessary or desirable for simplifying rationalising and streamlining the work in the projects including method of recording measurement for installation of sophisticated

electrical and mechanical equipment. This Committee shall also examine possibilities of suitable provisions in the specifications to facilitate identification of various items of installation work so as to simplify and minimise the process of recording the measurement.

7. In view of the complexity of the modern plant and equipment, it becomes necessary to carry out a number of quality control or probing tests on materials as well as sub-assemblies and assemblies of the plant and equipment in the course of manufacture. It is customary that in terms of the purchase contract, the purchasers' representative also witnesses a number of these tests. Some of the materials tests or type tests of equipment (*e.g.* EHV circuit breaker) and have to be carried out by authorised well-equipped laboratories and duly certified by them. The witnessing of these tests on behalf of the purchaser is generally the function of his purchase organisation and is often a part of the design and engineering services given by the consultants. The necessary capability in this respect does not appear to be available in the country presently. It is, therefore, strongly recommended that the organisations in the Government as well as in the private sector, active in the field of Consultancy services for power projects, should build up the necessary expertise and capacity for rendering this service (of inspection and witnessing of tests) to the project authorities. It is particularly desirable that the S.E.O. in CWPC should be equipped for this kind of work so that the needs of the Central projects are met and requisite assistance given to any project where desired.

8. As regards the testing facilities, it is believed that very considerable sophisticated facilities have already been created in the country in the different National and other laboratories as well as educational and research institutes like Indian Institute of Science, Central Power Research Institute, University of Roorkee, CWPRS etc. The immense advantages of appropriate quality control tests are often being lost for want of information regarding the availability of these facilities. The facilities are also in disuse and are not being developed further for want of adequate clientle. It is, therefore, recommended that the Specialised Engineering Organisation of CWPC should make a comprehensive survey of such facilities both within the manufacturing organisations as well as in other established institutions such as mentioned above and catalogue them for the use of project authorities. Some efforts in this direction have already been made by the Research Development Organisation of Electrical Industries (Bhopal) but these do not perhaps cover the requirements of the power projects fully. This survey should be carried out in close consultation with the manufacturing units, so that their programmes and practices of quality control and testing etc. are fully taken into account.

16. MISCELLANEOUS BOTTLENECKS

There are a number of miscellaneous causes of delays which have to be taken care of. Amongst these, land acquisition and rehabilitation is a serious problems. Labour strikes and civil disturbances also can cause substantial delays. Then there are a number of matters requiring clearance of various local/State authorities *e.g.* by the Director of Industries (for location of a power station which is an industry) inspection by the Chief Inspector of Boilers, inspection by Chief Electrical Inspector etc. These require timely expediting action by the project authorities. These bottlenecks have already been covered by the Shortfall Committee (*vide* extracts of Shortfall Committee Report given in Appendix-2). Their observations are valid in present times also.

The project authorities should be well aware of these difficulties and timely action should be taken for tackling these matters at the appropriate level so as to obviate any delays.

17. PROJECT ORGANISATION AND MANAGEMENT

1. *Project Manager*: It is essential that every project should be organised from the beginning under a suitably qualified and experienced Project Manager, who is in overall charge of the project, is vested with adequate financial and administrative powers including powers for placement of contracts. A surprisingly large number of projects have suffered badly for want of this obvious arrangement. For power stations construction-in-charge stationed at site is necessary from the very beginning.

2. It is highly advisable to adopt modern management methods for execution of the project. The project organisation should be such that the responsibilities at every level are well identified. A specific person should be responsible for proper completion of each specific item of work.

3. *Design and Engineering—Consultancy Services.*—Appropriate design and engineering

support must be provided at each level and each stage. Where the project organisation or the Electricity Boards are not adequately equipped for this purpose, it is advisable to retain the services of an experienced Consulting Engineering Organisation such as the Specialised Engineering Organisation of CW&PC or other consulting engineers available in each specialised field.

3.1. With the increasing scale of operations required to meet the exponentially rising demands for power, the resources of the State Electricity Boards etc. in respect of experienced man-power for project execution is bound to be spread out thin. At the same time, with the use of larger and larger sizes of generating units and higher transmission voltages, the power projects are rapidly increasing in complexity. This points to the need for encouraging development of specialised groups of Consulting Engineers in the country. Without this, it will not be possible to meet the requirements of future economically and with adequate level of excellence. It will be recalled that when orders for execution of power projects on turn-key basis were placed with foreign firms in the past, the equipment suppliers invariably engaged the services of appropriate Consulting Engineering firms to do the project work for them. Development of specialised groups of consultants would also assist in pooling together the experience over the length and breadth of the country, thus achieving an increasingly higher level of capability and competence at a faster rate and bringing it to bear on every new project. It may be pointed out here that a review of the working of the projects in the past 22 years has clearly shown that the projects executed in a satisfactory manner, keeping close to the original estimates and target dates of completion, have invariably been projects which had adequate design and engineering support.

3.2. Such support can be had separately for different units of the project if so desired (*e.g.* design of cooling towers or communication system) and also for a few or all the stages in the project execution in respect of these units. The main stages, for example, would be designs, specifications, tender scrutiny, servicing of contracts and co-ordination, inspection of progress in manufacturer's works and witnessing of quality control and shop tests, construction supervision, erection supervision, field acceptance tests and commissioning tests.

4. *Modern Management Techniques.*—Given all the various elements discussed here and elsewhere for successful execution of the project, it is now well-established that it is highly desirable, and in many cases essential, to provide efficient and appropriate project management in order to achieve the best possible results. From the management view point, the causes for delays and increase in project costs as well as many other problems arising from time to time in the planning, construction and commissioning of the power projects may be identified as follows :

4.1.1. The top project authorities are often not aware of the precise impact of certain delays, particularly on project commissioning, and of completion dates which are crucial from a variety of considerations. This is mainly due to lack of an integrated system designed to report status and indicate potential schedule slippages.

4.1.2. There is lack of effective, close and continuous coordination among all participants. There may be no integrated scheduling and reporting method which would tie together all activities and milestone target dates, and which could discriminate between critical and non-critical aspects. Progress reports are not presently based on this kind of integrated scheduling and reporting system where all known or estimated data are uniformly programmed and analysed at one place. This, in turn, leads to differences and misunderstanding among different authorities at different levels concerning the impact of delays and the resulting effect on estimates of dates for completion of construction.

4.1.3. Project departments are not in possession of all necessary information for effective planning and control. Each has portions of information not known to others concerned and, sometimes, continue using data which is no longer valid.

4.1.4. Even imprecise definition and use of terms often clouds the meaning and common understanding of certain scheduled events such as "project commissioning" which may mean different points of scheduled progress to different personnel in the organisation.

4.2. These and other similar problems indicate the need for systematising the programme scheduling methodology.

4.3. There has been a rapid development in rationalisation and improvement of management methods in the recent years mainly for meeting the needs of complex defence, astronautical and nuclear development projects; and these can now be adopted in our power projects very beneficially. In essence, these methods are based on the "Systems" approach to the question of project management and control. Proper planning of the project work at all stages, marshalling of all the resources (material as well as human) in appropriate combinations at every stage, proper inter-meshing of the vast number of different activities by different agencies and monitoring and control of the project by watching the progress of physical achievements as well as spending of funds in a rational manner are the main techniques by which an optimum efficiency and speed is sought to be achieved.

5. *Performance Budgeting.*—For proper budgetary control, the system of "performance

budgeting" has been evolved in the past few years in the U.S.A. This system constitutes a major advance in that, it enables intelligent financial management for the project.

5.1. In the past, progressing of development projects has suffered greatly on account of the fact that there was no means of correct appreciation of the progress of a project by the Government or the top Administrative Authorities. The progress was usually watched in terms of booking of expenditure to the different "heads of accounts". The account heads, such as "work", "establishment—salaries", "establishment—allowances", etc. may have been convenient for accounting purposes in their own way but did not serve to give any indication of the performance in respect of project execution. A system of "performance budgeting" has, therefore, been evolved in the past few years for correcting this position. Basically this involves booking of the expenditure output-wise rather than input-wise. (By outputs are meant the objectives and achievements).

5.2. This is a very valuable tool of management. The value of this has already been recognised by the Government of India and on the recommendations of the Administrative Reforms Commission, performance budgeting is being introduced progressively in the working of Ministries dealing with large projects. In particular, the performance budget has been prepared for the Ministry of Irrigation & Power for the first time in 1969-70. In the performance budget for 1970-71, improvements have been introduced by making the programme classifications more rational and by regrouping the activities of the Ministry according to the objectives represented by the major programmes. Efforts are also being made to develop and introduce a suitable reporting system so that the performance budget could be used as an effective tool of management.

5.3. In view of these developments, it is felt that the time is now ripe for introduction of performance budgeting at different levels in the work of project execution. This action is strongly recommended. A note explaining the basic principles of performance budgeting is attached as Appendix-6. As mentioned in the note, it is important that all the elements of improvement should move forward simultaneously. In particular, adequate and proper accounting support, an efficient system of information and reporting and an improved organisation and programme management are absolutely essential.

6. *Network Techniques*

6.1. In the adoption of performance budget methods as well as "Programme Evaluation and Review" of the physical aspects of construction work in complex projects, information and control system based on PERT/CPM Network Technique can be adopted with great advantage. It is necessary to introduce the use of these techniques from the earliest possible stages of the project and preferably even to cover the planning stages also. Establishment of a PERT Cell to cover all projects of an organisation as well as individual PERT Cells for each project or even its major elements is very desirable. Suitable design or re-working of the PERT outputs for a more effective handling of progressive meetings at all levels is also necessary.

6.2. A note on the essential features of these techniques and the recommendations in that respect are given in Appendix-7.

7. *Management Information System*

7.1. The above techniques cannot be adopted in isolation. They have to be integrated in a comprehensive management information and control system. The salient features of the system design would briefly be as follows :

7.1.1. The system should provide information on Cost and Time for use by management in the decision-making process.

7.1.2. The system may be patterned on the principle of management by exception.

7.1.3. A major portion of the information and reporting system may be based on the use of Network Technique (PERT/CPM) for controlling the scheduled progress of work at the project level.

7.1.4. The design should include feed-back reporting into the system.

7.2. The objectives of this Management Information System being focussed on achieving *on-time* and *on-cost* completion of each phase of power project development, the following three principal control parameters may be used.

(i) Schedule date of starting construction;

(ii) Scheduled date of starting power generation or production.

(iii) Construction Budget.

7.3. The system functional design has to include :

(i) Data collection

(ii) Data storage and retrieval

(iii) Analysis of data for production of information

(iv) Preparation of output in terms of reports, displays, etc.

7.4. A suggested management information system for power projects has been devised and is given in Appendix-8. This is presented only by way of an illustration.

8. It is desirable to supplement the foregoing control and monitoring of the project progress by incorporating in the purview of project planning and monitoring, activities of outside agen-

cies, such as Railways, authorities concerned with water supply, equipment manufacturers etc. A better and detailed understanding with equipment manufacturers as regards the scope of supply, procedure for review of drawings, equipment inspection, construction procedures etc. is necessary for achieving a better balance among field erection work, job fabrication work and start-up procedures etc.

9. A wide and effective use of inspection and expediting cells to keep track of the progress of equipment manufacture and delivery is extremely desirable.

---

18. MARSHALLING OF RESOURCES

In view of the ever increasing scale of project execution in the field of power and considering the relatively small industrial base available in India compared to more advanced countries, there is the danger of saturation of our resources for project execution and throttling our progress thereby. This can occur in respect of technical manpower, important materials like steel and cement, manufacturing capacity for power plant and equipment, capacity for civil construction work and above all, design and engineering capability. This matter, therefore, requires urgent attention at the National level. Proper material/resource balances need to be worked out to identify areas where action is required for enhancing our capabilities in the light of overall requirements. Proper planning and programming to dovetail the requirements of different projects into our capabilities is also essential.

1. An important matter is the total project handling capacity available in the country by way of Consulting Engineer Services for projects. It has been quite clear for quite some time past that the design and engineering capability available in the Government organisation like CWPC and State Electricity Boards is not being built up at a sufficiently fast rate. The CWPC in particular has the dual role of being Consulting Engineers to Power Projects and Technical Advisers to the Central Government. It is, therefore, essential to ensure that the design and engineering capability as well as the expertise in specific areas of complexity is built up in the CWPC by pooling together the experience in power engineering over the entire length and breadth of the country. For this purpose, it would be advisable to have a two-pronged approach. The design and engineering capability as well as the capability of functioning as expert technical advisers has to be built up through extensive and comprehensive project work. In addition, there should be a panel of experts available in the State Electricity Boards, Universities and other organisations in the country and standing arrangements should be made so that the CWPC can avail of the expertise of these persons whenever required at short notice. With our limited resources in the shape of top level experts, we can ill-afford to let the experts operate in segregated manner and proper marshalling of the expertise is a necessity.

2. The need for design and engineering services for power projects will arise in a big way—partly on account of the ever larger programme of new projects and partly due to the need for greater design and engineering support (than in the past) for better project execution. The designs units in the State Electricity Boards/Electricity Departments the Specialist Engineering Organisation of CWPC and Consulting Engineer firms presently available will all have to develop and expand. In view of the CWPC's roll of pooling together the expertise and since its own capability can be built up only through project engineering and design work, it is an urgent necessity to undertake a deliberate programme for building up of the Specialised Engineering Organisation of CWPC. It must be remembered that this cannot be done overnight and is too serious a matter to be dealt with in an *ad-hoc* manner. It is gratifying to note that some of the leading organisations in the private sector in this field have shown commendable rate of development and progress.

3. Need has also developed for organisations which can take up erection work of the complex plant and equipment for power projects. Formerly, this used to be done mainly by the equipment manufacturers who would undertake either the complete erection and commissioning of the plant and equipment or at least complete supervision and guidance of erection. The new indigenous manufacturers like M/s. HE and M/s BHE have, however, their hands full with problems of organising manufacture of the plant and equipment which is their primary function. So far they do not appear to be organised to take up erection of the plant and equipment or even the overall supervision of erection to the extent that foreign suppliers used to do. There is, therefore, an urgent need for organisations (contractors) who could undertake such work. Fortunately, a number of erection contractors have started coming up in the last few years and if this trend continues, there should be no difficulty in this regard.

4. There is also the urgent need of developing the technical man-power resources. It is something of a paradox that while there is growing concern about increasing unemployment of technical men, there is scarcity of adequately trained and experienced personnel to man a number of

important jobs at all levels. At the level of technicians, there is the present scarcity of experienced welders and instrument mechanics. Scarcity in respect of other skills may also occur and adequate steps to forestall these are advisable.

5. *Manufacturing Capability.*—As stated in the earlier Sections (Section 10—Procurement), all the plant and equipment now required for increasing the installed capacity of power plant are being planned to be obtained entirely from the indigenous manufacturers, *viz.* M/s. HE and M/s. BHE. These manufacturing units, however, are having considerable difficulties in getting into a stride and number of projects are already being delayed on account of delays in supply of equipment from these manufacturers (*see* Tables 3 & 4). Future requirements would be increasing at an exponential rate and, from the practical viewpoint, it is doubtful if we would actually be able to get on schedule, all the future requirements of generating plant and equipment from these internal sources. Both M/s. HE and M/s. BHE have unfortunately delayed building up their full design and manufacturing capabilities. Delays in other heavy engineering projects which were to act as feeder projects to these manufacturing units have greatly increased the difficulties of these indigenous manufacturers. If we insist on obtaining all the future requirements of plant and equipment only through these manufacturing units, there will understandably be long delays in achieving the augmentation of power systems to the level necessary for continued industrial and agricultural growth from year to year. The economic loss to the country due to such retardation of industrial and agricultural development will be colossal While, therefore, every effort should be made to accelerate the pace of growth of the capabilities of M/s. HE and M/s. BHE as much as possible, it would not be prudent to allow restricted indigenous manufacturing capability to limit the rate of growth of the power supply industry. It is, therefore, recommended that import of plant and equipment to the extent necessary for uninhibited growth of the power sector should be considered and approved by the Government.

5.1. Import of plant and equipment will, of course, raise a number of problems and the policy regarding these will have to be thought out in advance. Firstly, the indigenous manufacturing units could themselves increase their through-put by import of manufactured or semi-manufactured components on a large scale. This will increase the volume of indigenously obtained equipment but, only notionally. From a National viewpoint, it would be desirable to make a financial/economic analysis to see whether this method yields any real benefits particularly an savings in respect of cost of equipment and foreign exchange. It would not be reasonable to burden the power projects with additional costs and to accept an additional drain on foreign exchange merely for a national increase in indigenous manufacture. Direct import of plant and equipment from abroad would then be in the National interest.

5.2. Such a situation could also be turned to an advantage. As already mentioned (Section 6—Planning), it is likely that larger sizes (ratings) of generating units may be more attractive from economic considerations for some of the future installations. M/s. HE and M/s. BHE may require considerable time before such large units are included in their manufacturing programme. If, however, some imports have to be made because of saturation of their capacity as discussed above, these imports could bring in the large-sized units.

5.3. Since the imported equipment, is likely to be cheaper than the indigenous equipment, some manner of price equalisation will have to be worked out so that no project suffers on account of having to accept indigenous equipment.

5.4. In importing plant and equipment as recommended here, care must be taken to ensure that indigenous capacity for manufacture of certain sub-systems and components is fully utilised, for example, coal handling plant, water treatment plant, steel work for power stations, piping etc.

6. *Scarce Materials.*—It will be an important task of the Design Organisations to take note of materials likely to be in short supply and to develop designs to get around such problem areas. This will also present many challenging and rewarding tasks to the Research Organisations. Close collaboration of the Designs and Research Organisations on such matters is highly desirable.

7. *Construction Plant and Machinery.*—This is an important item which has often retarded or even held up progress of construction projects. Economic and efficient operation and maintenance of the plant and machinery used in construction work is highly important for smooth progress of the construction work according to schedule. A good deal of equipment has been imported in the country but satisfactory utilisation thereof has often been hampered for want of spares etc. The requirement of construction plant and machinery of a project varies from time to time during its progress. Considering the large investment (and foreign exchange) required and the rather specialised team work required for its efficient operation as well as maintenance, it appears desirable that each State Electricity Board should form a pool of construction plant and machinery for all its construction projects. Each project should draw upon this pool in respect of the equipment spares as well as operation and maintenance personnel according to its needs from time to time. For purposes of spares etc., a co-operative pooling of the resources at the level of the Regional Electricity Boards may be useful. The Regional Electricity

Boards can assist by keeping consolidated inventories of the equipment and spares available at different projects or with the different State Electricity Boards in the region. This will facilitate better utilisation of the equipment and also reduce the down time for want of spares. At the National level, it would be useful if a Central Organisation like CWPC could take a census of the plant and machinery and its current condition from time to time so that economic and efficient use of this can be made by the different construction projects. It is necessary to take stock of the position in regard to the equipment available in the country and its optimum utilisation. For this purpose, the Government of India have already appointed a Committee with fairly detailed terms of reference (*see* Appendix 9). It is hoped that the report of this Committee will bring into focus the further lines of action.

---

19. FUTURE PATTERN OF PROJECT EXECUTION

1. This is closely linked with the long term perspective of electric power development in the country. Another Study Group (Study Group-3) had already studied in detail the various factors in the choice of schemes for expansion of electricity production and supply in the country. One important conclusion is that the long-term economic perspective plant would have to be drawn up for the entire country for the power sector as such and correlated and fitted into the overall economic plans. Future power development cannot be organised rationally and economically on a State basis and a perspective plan on a regional basis is, therefore, proposed. Already the Fourth Plan recognizes this as a basic feature for future planning which has been accepted by the National Development Council. The Study Group has rightly come to the conclusion that under the circumstances the overall responsibility for planning for power including investigations and processing of schemes right up to the point of initiation of construction should be centralised. It has been suggested that even as an immediate measure, the Planning Commission should ask all State Electricity Boards and State Governments for a list of all proposals for expansion of power generation and supply on the most economic lines along with feasibility reports based on investigations carried out. The Planning Commission would make it clear to the State Governments that the object is to locate all economically beneficial schemes. These are then to be considered for implementation on the basis of the requirements of the region as such. On techno-economic considerations, power schemes may be taken up to meet the demands in an area irrespective of the State boundaries and the finances will also not be restricted to the resources within the State Plans. In future, also following the decisions taken at the National Development Council, priorities for schemes of power generation and supply should be based on choosing the most economically beneficial ones in each area.

2. In the context of the above, it is clear that the Centre will have to play an increasingly active role in the field of power generation and transmission. Since the projects for implementation are chosen on considerations transcending State boundaries and irrespective of the financial resources of the State, it is necessary for the Centre to build up the capability to undertake execution of the schemes wherever necessary.

3.1. There are also other compelling reasons why the Centre should be prepared to undertake execution and later perhaps even operation of large power project. The cost of energy generation and supply has now to be drastically controlled and reduced. Full utilisation of available generating facilities has to be ensured and the best possible use has to be made of the limited funds available for making up the estimated shortages of power and energy, as much as possible. Careful studies have pointed to the necessity of undertaking a massive programme of adding hydro-electric generating capacity in the next two Plans (Roughly 2/3rds of the new generating capacity would be hydro). The balance of the new capacity will come from large steam power stations and nuclear power stations. Some large steam power stations would have to make optimum use of coal-washery-by-product fuels for yielding substantial economies for power as well as steel industries. Other large power stations would have to be mine-mouth stations on account of their large sizes. At places remote from the collieries and from large base load hydro stations, nuclear power generation would have to be resorted to.

3.2. In these major power developments, it is obvious that the nuclear power generation will always be entirely the responsibility of the Centre for planning and installation as well as for operation. The reasons for this are too well-known. For thermal stations using washery-by-product-fuels or low grade coals also, the Centre should bear the chief responsibility. Such power stations are faced with a large number of complex technical problems (which have been discussed in detail in the Report of Study Group-1) and their planning as well as operation have to be closely co-ordinated with the setting up and operation of the washeries and opening of new collieries. On account of problems of by product fuels, State Organisations would understandably be reluctant to own and operate such

power stations-involving large investments. In the case of large hydro-electric power stations, it is evident that stations of the future will have to tap more remote resources or resources that are too big to be developed by a single State on its own with project areas extending across State boundaries. Joint usage and diversion of water for different purposes may be involved. The large requirements of funds, man-power and other resources for project execution are some of the main things that would make execution of these projects by the Centre or Regonal Electricity Board desirable.

3.3 In view of the importance of the foregoing considerations, the matter was discussed at the Fifth Conference of the State Ministers of I&P held at Ootacamund in September, 1970. It was decided to set up a Committee of the following to examine all aspects of Central generation through Regional Agencies and submit its report within six months :—

Secretary, Ministry of Irrigation & Power	Chairman
Vice-Chairman, Central Water & Power Commission	Member
Five Secretaries dealing with Power from State Governments.	Member
A representative of the Ministry of Finance	Member
A representative of the Ministry of Law	Member
Adviser, Planning Commission	Member
Joint Secretary, Ministry of I&P	Member-Secretary

The recommendations of this Committee would, no doubt, point the way for future action in this regard.

4. *Working of Electricity Boards*

4.1. Presently, it is the States that are playing the main role in the matter of power generation and transmission. In the area of planning, field investigations and preparation of projects, there is an immediate need for accelerating the tempo of the work many times over partly to make up for the lag in this work in the past years and partly to keep up with the larger requirements of the future years. Presently, the State Electricity Boards are engaged in multifarious activities embracing operation and maintenance of the generation and transmission works, co-ordinating O&M of distribution networks and rural electrification which make heavy demands on the time of the Chairman, Technical Member on other technical personnel. It is not possible for them to devote enough attention to the long-term problems of planning for the future as well as construction, as the demand of present day problems regarding system operation, rural electrification and the like are urgent. Action on the following lines is, therefore, considered an urgent necessity in the State Electricity Boards.

4.2. The top management needs to be strengthened and organised so that they are in a position to give greater attention to planning, investigations, project preparation and project execution. This is a very big task and demands intimate knowledge of all aspects of power engineering. There is also the need to adopt latest technological advances in a practical manner. A stage has, therefore, been reached when each State Electricity Board should be headed by an experienced power engineer as the Chairman of the Board. All technical work should be put directly under the charge of two technical members. One of the technical members should be exclusively in charge of the planning, investigations, project execution etc. for generation and main transmission projects. He should also be in charge of the power stations and their integrated operation in the State or Regional Grid. The other technical member should be in charge of all the remaining matters including commercial matters. He should also be in charge of the planning and construction as well as operation of the sub-transmission and distribution systems throughout.

4.3. Some variations in the above recommendations are, of course, possible. Depending on the scale of activities, some Electricity Boards may be able to manage with a power-engineer as Chairman and one technical member for all the generation works and planning and investigations but in the case of larger Boards, two technical members and a technical Chairman would appear to be desirable.

4.4. It is further felt that reorganisation of the Electricity Boards into two Wings under the two Technical Members is very necessary in order that adequate attention may be paid at all levels to the future planning, project execution and integrated operation. It is these matters that would play a crucial role in effecting economy and making electricity available to the consumer in adequate measure at as low a rate as possible.

4.5. It has been the experience in a number of places that at the lower technical levels, it is difficult to ensure continuity of experience and service in a sufficient measure for more technical work such as in generation projects. The personnel from the generation projects get dispersed on other works and it is difficult to find persons with adequate experience and training for the highly technical work involved. It is, therefore, suggested that as already recommended in the report of Study Group-I, a separate generation cadre should be formed. Within the cadre, it would be desirable to have considerable mobility of persons between the different functions such as operation and maintenance, ~~design~~ planning etc.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Present Position

1. There are serious shortfalls in achieving the targets for installation of generating capacity and transmission system in the country, year after year. If this trend continues there are grim prospects of wide-spread and serious shortages of electric power. Further, on account of inadequacy of advance planning and investigations, there is likelihood of serious power shortage in the 5th and 6th Plans also, leading to grave consequences in retardation of industrial and agricultural activity and economic progress. Concerted action on a wide front is essential for correcting this position and making up for the lost ground.

Causes of Delays

2. Causes of delays in the projects taken up for implementation have been identified and are listed in Section 5 of the report.

Planning

3. A fairly large programme of construction has to be in hand all the time in order to keep up with the normal load growth. This is in consonance with experience in other countries also.

4. The perspective plant for the next 15 years should be available at any point of time and, every year, such plan should be up-dated and extended to cover the future 15 years. Advance action in respect of preliminary investigations and designs and estimates should proceed in a continuous manner. The proposals for the next 10 years should indicate details of the specific projects to be undertaken and their time-table of the major stages. The plans for the first 5-7 years should be very definite at any time and should be already under implementation.

5. Planning for electric power should be organised on a nation-wide basis. The overall responsibility for planning, including investigations and processing of schemes right upto the point of execution should be centralised with the Central Electricity Authority. The existing legislation is adequate for this.

5.1. Each State Electricity Board should have a Planning Cell which will be capable of taking into account the long range needs for electric energy as well as utilisation of the resources in the best possible manner.

5.2. Similar long-range Planning Cells should also be created in the Regional Electricity Boards. These should be able to co-ordinate and correlate the plans prepared by the State Cells so as to make the best utilisation of the available resources in the Region.

5.3. At the Centre, the Planning Commission and the CW&PC should keep in constant touch with the work and progress of these Planning Cells at the Regional and State levels and a long-term power plan should be evolved continuously.

6. There is an urgent need for strengthening the Civil Engineering Organisation in each Electricity Board in order to cope with the large programme of investigations, planning and construction required for hydro projects. An experienced Chief Engineer (Civil) should be appointed for each Board. Among other things, he should be in overall charge of a whole time planning and investigation circle.

7. The indigenous manufacturers should plan the manufacture of further larger sizes of generating units so that these are available in time when the power systems require these, shortly.

Investigations

8. A massive and continuous programme of field investigations is needed immediately in each Region of the country, so that the needs of the Fifth and Sixth Plan periods for investigated projects can be fulfilled.

9. The CWPC should keep in close touch with these investigations so that these proceed on fruitful lines, technically, throughout.

10. The finances for project investigations should be provided in the initial stages as "on account grants" in the nature of promotional expenses. These expenses can be reimbursed to the common fund from the project estimate when a project is taken up for execution.

11. Detailed investigations should be entrusted to well-organised Survey and Investigation Units (in each State) equipped for geological as well as other investigations. Services of the Research Stations such as CWPRS, CSMRS etc. should be utilised for arriving at adequate scientific data. Keeping the design engineers associated with the investigation work also proves valuable in ensuring proper orientation of the investigations and avoiding fruitless efforts.

12. Where inter-State development of a resource is indicated, the Regional Electricity Boards should take up the work. Formation of a River Valley Authority to take the responsibility for further detailed project investigations and subsequent execution of individual schemes in the River Valley (according to a time-table prescribed by the perspective plan) may also be considered.

13. After the feasibility of a hydro-electric project is established, construction of the minimum access road facilities should be taken up immediately from the 'investigation funds'. This will enable expeditious detailed investigations.

14. When a project is sanctioned, the construction of the access roads should be undertaken and completed at the earliest. This will expedite the execution and completion of the project.

Project Preparation

15. The model proforma circulated by the Planning Commission should be followed strictly for the preparation of project report. This will eliminate protracted correspondence and resultant delays in sanctioning of the projects.

Financing

16. In order that the Project Authorities can plan and execute the construction programme according to the plan schedule, the finances should be made available as per the phased requirements of the project.

17. Power Projects sometimes suffer due to diversion of funds to other purposes by the State Government. This could be discouraged by the Planning Commission by "earmarking" the funds for specific projects at the time of formulation of plan provisions.

18. In the past there has been a great deal of excess expenditure as well as slippages in achievements of targets in the case of both generation and transmission. This is on account of two reasons, *viz.*

(i) Under estimation of cost at the time of preparation and sanction of the project report; and

(ii) Rising costs of materials, labour and other services like transport etc. in the course of project execution.

19. The under-estimation of the cost is mostly due to lack of adequate investigations and inadequate or incompetent design and engineering. It is, therefore, very essential to have thorough and detailed investigations and sufficient preliminary designs as the basis for realistic estimates of the time and the cost of project execution.

20. The CWPC should be charged with the responsibility for the accuracy of the estimates of time and cost of project execution. The CWPC should organise and equip itself for such work without any delay.

Procurement

21. Tender specifications should be as detailed as possible and should include listing of all the information (such as technical data, requirements of firm deliveries, contractual and financial requirements, etc.) required of a tenderer.

22. M/s. HE and M/s. BHE should make their quotations thoroughly business like by furnishing detailed lists of all equipment and accessories they would supply and the supplementary equipment that the project is expected to procure from elsewhere to make the supply complete.

23. A good many items of plant, their ancillaries and other items have been standardised; the purchase specifications should be based on these as far as possible.

24. A model "general conditions of contract" applicable to public sector and, if possible, to private sector manufacturers, binding on all the parties, would reduce the time between the receipt of the tenders and placing of the orders, and should be prepared and adopted.

25. The manufacturing capacity presently available in the two manufacturing units, *viz.*, M/s. HE & M/s. BHE is not sufficient to meet the requirements of the country fully. There is, therefore, no need at present for competitive bidding between them and their energies should not be so diverted.

26. The model technical specifications (prepared by CBI&P Working Group) for each type of hydro-electric turbo-generator set based on each of the technologies adopted by M/s. HE and M/s. BHE should be adopted for ordering of the hydro-electric generating units. Considerable saving of time and effort can thus be effected.

27. It is possible to secure overall economic advantage by grouping the orders placed on the two manufacturing units for different projects rationally, so as to obtain optimum benefits regarding development and designs. This matter is complex and requires a cautious and informed approach. The planning of the orders may, therefore, be done in consultation with CWPC.

Manufacture of Equipment

28. The manufacturer should indicate his need of foreign exchange (source as well as the amount) at the time of tender. The concerned Ministries should ensure the release of adequate foreign exchange.

29. The manufacturer should indicate all factors and assumptions on which their promise of delivery period is based. It would be desirable as a contractual obligation for the manufacturers of major items to furnish the project authorities with their PERT network chart for items of their supply including exchange of drawings and data.

30. Manufacturers should attempt to reduce the erection work at site to a minimum by adopting shop assemblies in as large a measure as possible. For this purpose, special wagons/transporters may be devised, if necessary for transport to site.

31. The Ministry of Irrigation and Power should be responsible for assigning priorities and programmes for the manufacture of equipment for various projects in consultation with all concerned.

32. There is much scope for standardisation and rationalisation of manufacture of a number of sophisticated items like automatic voltage regulators, excitation equipment, governors for generating sets etc. The Manufacturing Units and CWPC should work jointly to achieve this.

33. In view of the monopoly of M/s. HE and M/s. BHE in respect of generating plant and equipment, it is imperative to devise a mechanism whereby it can be ensured that the Manufacturing Units will strive towards attaining better efficiencies and producing increasingly superior machines. A Standing Advisory Committee comprised of representatives of the two manufacturers, CWPC and one or two academicians should be set up to decide the targets and co-ordinate the action in this regard.

Transport Facilities

34. The Design Organisation of CWPC should survey and catalogue the special transporters available with the various organisations so that the different projects can draw upon these when required.

35. In view of the increasingly large sizes of generating units and other equipment, special transport equipment presently available will not meet all future needs. The CWPC in consultation with M/s. HE and M/s. BHE should take up the matter with the Railways for design and construction of special wagons, mobile cranes etc.

Shortages and Breakages in Equipment

36. Whenever any shortages or breakages are revealed, the project manager should have these inspected on his own and should proceed with ordering of the replacement. The process for making the insurance claim and necessary inspection, etc. therefore can proceed separately simultaneously. The procedure of ordering the replacement should be initiated immediately after damage or shortage comes to notice, without waiting for acceptance of the claim by the Insurance Company.

Construction Equipment and Plant

37. The engineer in charge of the project should decide the extent of mechanisation at the design/planning stage after taking the various factors into consideration. The procurement of construction equipment and plant should be initiated well before the start of the execution of the project so that it is available in time.

Construction Contracts

38. For timely execution of the project, it is necessary to draw the overall project schedule as well as the schedules for the construction jobs proposed to be handled on contract before inviting tenders, or in any case, before awarding the contract. Such schedules should define the required date for any significant point of communication or transfer of responsibility between the contractor and other participants on the project.

39. The ability to control a construction project, most elements of which are given on contract, depends largely on the soundness of the contract documents themselves. A loosely defined contract may create considerable dissensions between the contractors and the project management due to individual interpretations of the intent as well as contents of the contract.

40. During the course of execution of the contract, the Project Management should retain full authority under the terms of contract to request any measures that may be necessary for the proper and timely execution of the work. The project personnel should constantly watch the project and evaluate the effect of slippage on the part of any contractor, on the rest of the project.

41. Most of the needs of generating plant are going to be met from the indigenous manufacturers M/s. HE and M/s. BHE, who are not sufficiently equipped to undertake erection work of their own equipment. The Electricity Boards should, therefore, build up suitable teams for undertaking the work of installation and commissioning of plant and equipment. Such teams will be of great value to the organisation in arranging overhaul and proper maintenance work also.

42. In the absence of free exchange of ideas between the contractors and project officers, there are considerable difficulties regarding measurement or assessment of work done, contractual obligations and responsibility of different parties etc. These difficulties are increasing with the increasing complexity and volume of project construction work. Some organisation like the Institution of Engineers (India) should bring together the contractor firms and project execution people to evolve a common understanding of the problems and to work out possible solutions.

43. The accounting proformae and procedures prescribed for the project works of complexity, particularly the electrical works, do not suit the work involving complex technology. The Ministry of I&P should appoint an Expert Committee to go into the methods, detailed rules and proformae and suggest changes for simplifying and rationalising the work in the projects including methods of recording measurements.

44. The consultancy organisations should build up the expertise and capacity for undertaking inspection during manufacture and witnessing of tests on behalf of the projects.

45. The CWPC should make a comprehensive survey of the facilities available in the country for undertaking quality control "type" and other proving tests and catalogue these for the use of Project Authorities.

Miscellaneous Bottlenecks

46. The project authorities should be aware of the various possible serious bottlenecks such as land acquisition, rehabilitation, labour strikes, clearances of local/State Authorities, etc. and timely action should be taken for tackling these matters at the appropriate level.

Project Organisation and Management

47. It is essential that every project should be organised from the beginning under a suitable qualified and experienced project manager who is vested with adequate financial and administrative powers including placement of contracts.

48. Modern Management methods need to be adopted for efficient and timely execution of the projects. "Systems" approach to the question of project management and control should be adopted. Proper planning of the project work at all stages, marshalling of all the resources (material as well as human) in appropriate combinations at every stage, proper intermeshing of the vast number of different activities by different agencies and monitoring and control of the project by watching the progress of physical achievements as well as spending of funds in a rational manner are the main techniques by which an optimum efficiency and speed can be achieved.

49. PERT/CPM network techniques should be introduced from the earliest possible stages of the project and preferably even to cover the planning stages also. Establishment of a PERT Cell to cover all the projects of an organisation as well as individual PERT Cells for each project or even its major elements are very desirable.

50. These Network techniques have to be integrated in a comprehensive management information and control system. The objectives of this management information system should be primarily based on achieving *on time* and *on cost* completion of each phase of the power project. A model management information system has been given in the Report.

51. Where the project organisations are not adequately equipped it is advisable to retain the services of an experienced consulting engineer organisation such as the Specialised Engineering Organisation of CW&PC or other Consulting Engineers available in each specialised field.

52. The system of "performance budgeting" should be adopted as an important management tool for monitoring and control of a project.

Marshalling of Resources

53. Nation-wide survey and planning is necessary to ensure adequate resources for construction projects in respect of construction materials, equipment manufacture, construction machinery and design and engineering capability.

54. There should be a panel of experts who may be available in the State Electricity Boards, Universities and other Organisations in the country. Standing arrangements should be made so that the CW&PC or the projects can avail of the expertise of these persons whenever required, at short notice.

55. In view of the ever increasing scale of project-execution in the field of power, there is an urgent need of expansion of the design units in the Electricity Boards/Undertakings, the Specialised Engineering Organisation of CW&PC and Consulting Engineer Firms.

56. The CW&PC has the dual role of being Consulting Engineers to the power projects and Technical Advisers to the Central Government. There is an urgent necessity to undertake a deliberate programme for building up of the Specialised Engineering Organisation of CW&PC in order to ensure that the design and engineering capability in specific areas of complexity is available.

57. There is an urgent need for developing technical manpower resources to remove scarcity of adequately trained and experienced personnel for manning technical jobs at all levels. This will also help reduce growing unemployment among persons passing through technical institutes.

58. Every effort should be made to accelerate the growth of the capabilities of M/s. HE and M/s. BHE and their feeder projects so that the future requirement of plant and equipment for power projects can mostly be met by these.

59. Where M/s. HE and M/s. BHE cannot cope up with the needs of the power supply industry for enabling it to meet the needs of growth of industry and agriculture, import of plant and equipment to the extent necessary for uninhibited growth of the power sector should be approved.

60. Close collaboration of the Design and Research Organisations in the country should be established for developing designs to get around problems of scarcities of certain materials arising from time to time.

61. Each State Electricity Board should form a pool of construction plant and machinery for all its construction projects. Each project should draw upon this pool in respect of equipment, spares as well as operation and maintenance personnel according to needs. The Regional Electricity Boards should assist by keeping consolidated inventories of the equipment and spares available at different places or with different Electricity Boards in the region facilitating better utilisation of the equipment and reduction of down time for want of spares. At the national level, the CWPC should take a census of the plant and machinery and its current condition

periodically and make this information available to the Electricity Boards/Construction Projects.

Future Pattern of Project Execution

62. In view of the ever increasing tempo of project execution in the field of power, the Centre will have to play an increasingly active role. The Centre should take immediate steps to review and strengthen the Central Electricity Authority.

63. For a number of reasons discussed in the report, it would be desirable for the large or Inter-State projects to be taken up for execution by the Regional Boards or by hte Centre.

64. Presently, the State Electricity Boards are engaged in multifarious activities and adequate attention cannot be given to the problems of long-term planning etc. The top management should, therefore, be strengthened and organised by having the State Electricity Boards headed by an experienced power engineer as the Chairman and by putting all technical work directly under the charge of two technical members heading two Wings of the Board.

LIST OF TABLES

TABLE 1-1

GENERATING UNITS SCHEDULED FOR COMMISSIONING DURING IV PLAN
1970-71

Sl. No.	Name of Project	Capacity		Country of Import/ Name of Manufacture	Remarks
		Imported	Indigenous		
1	2	3	4	5	6
	ASSAM				
1.	Umiam (2×9)	18·0		Japan	Since commissioned.
	BIHAR				
2.	Kosi Hydel (1×5)	5·0	—	Japan	II Unit
3.	Barauni Extn. (1×50)	50·0		Poland	II Unit
	GUJARAT				
4.	Gas Turbines (2×27)	54·0	—	Italy	I Unit since commissioned.
	MAHARASHTRA				
5.	Nasik Thermal (1×140)	140·0	—	France	
	TAMIL NADU				
6.	Parambikulam Aliyar				
	(*a*) Sholayar I (2×35)	70·0	—	Yugoslavia	
	(*b*) Sholayar II (1×25)	25·0	—	Yugoslavia	
7.	Kodayar I Hydel (1×60)	60·0	—	Swiss/France	
8.	Ennore Thermal (1×55)	—	55	BHEL	II Unit.
	UTTAR PRADESH				
9.	Obra Hydel (2×33)	—	66	HEL	I Unit since commissioned.
	WEST BENGAL				
10.	Little Ranjit (2×1)	2·0	—	U. K.	
	DELHI				
11.	I. P. Station Extn. (1×55)	—	55	BHEL	
	HIMACHAL PRADESH				
12.	Nogli (2×0·5)	—	1	Indigenous 5th & 6th (M/s. Jyoti Units Ltd.)	
13.	Bassi (3×15)	—	45	HEL	
	TRIPURA				
14.	Diesels (2×0·5)	1·0	—	USSR	
	NON-UTILITIES				
15.	Singareni Collieries. (1×6)	6·0	—		Since commissioned.
	TOTAL	431 + 222		653 MW	

Source	*Capacity (MW)*
(*a*) Imported	431·0
(*b*) Indigenous	222·0
(*i*) HEL	111·0
(*ii*) BHEL	110·0
(*iii*) Jyoti Ltd.	1·0

TABLE 1-2

GENERATING UNITS SCHEDULED FOR COMMISSIONING DURING IV PLAN
1971-72

Sl. No.	Name of Project	Capacity		Country of Import/Name of the manufacture	Remarks
		Imported	Indigenous		
1	2	3	4	5	6
	ASSAM		—		
1.	Gauhati Thermal (1×30)	30·0	—	Japan	
2.	Tura Thermal (2×2·5)	5·0	—	Hungary	
	BIHAR				
3.	Kosi Hydel (2×5)	10·0	—	Japan	III & IV Units
4.	Partratu (2×100)	200·0	—	USSR	V & VI Units.
	GUJARAT				
5.	Dhuvaran (2×140)	280·0	—	U. S. A.	
	JAMMU & KASHMIR				
6.	Chenani (2×4+1×6)	14·0	—	Hungary	Ist 3 Units.
7.	Kalakot (2×7·5)	15·0	—	Yugoslavia	II & III Units.
	RAJASTHAN				
8.	Jawahar Sagar (2×33)	66·0	—	Canada	I & II Units.
9.	RAPP (1×200)	200·0	—	Canada	I Unit.
	MAHARASHTRA				
10.	Parli Thermal (2×30)	—	60	HEL	
11.	Nasik Thermal (1×140)	140·0	—	France	
	PUNJAB				
12.	U. B. D. C. (2×15)	—	30	HEL	I & II Units.
	TAMIL NADU				
13.	Ennore Thermal (2×110)	220·0	—	Czech.	III & IV Units.
14.	Kodayar II Hydel (1×40)	40·0	—	Yugoslavia	
	UTTAR PRADESH				
15.	Harduaganj Extn. (2×55)	—	110	BHEL	I & I Units
16.	Obra Thermal Extn. (1×100)	—	100	BHEL	II Unit.
	(1×50)	50·0	—	USSR	V Unit.
17.	Obra Hydel (1×33)	—	33	HEL	
	ANDHRA PRADESH				
18.	Ramagundam (1×62·5)	62·5	—	USA	
	KERALA				
19.	Kuttiadi (3×25)	75·0	—	Japan/Germany	
	MYSORE				
20.	Sharavathi (1×89·1)	89·1	—	USA	8th Unit.
	WEST BENGAL				
21.	Jaldhaka (1×9)	9·0	—	Japan	III Unit.
	NON-UTILITIES				
22.	Bokaro Steel (2×55 + 1×12)	122·0	—	USSR	
	TOTAL	1627·6 + 333	= 1960·6		

Source	*Capacity (MW)*
(*a*) Imported	1627·6
(*b*) Indigenous	333·0
(*i*) HEL	123·0
(*ii*) BHEL	210·0

TABLE 1-3

GENERATING UNITS SCHEDULED FOR COMMISSIONING DURING IV PLAN
1972-73

Sl. No.	Name of Project	Capacity: Imported	Capacity: Indigenous	Country of Import/ Name of the manufacturer	Remarks
1	2	3	4	5	6
	ANDHRA PRADESH				
1.	Kothagudem (2×110) . . .	—	220	BHEL	
	ASSAM				
2.	Namrup Extn. (1×30)	—	30	HEL (T/A) BHEL (Boiler)	
	GUJARAT				
3.	Ukai Hydro (3×75)	—	225	HEL	I, II & III Units.
	JAMMU & KASHMIR				
4.	Chenani (2×4·6)	—	9	BHEL	IV & V Units
5.	Upper Sindh (2×11)	—	22	HEL	
	KERALA				
6.	Iddikki (1×130)	130	—	Canada	I Unit.
	RAJASTHAN				
7.	Jawaharsagar (1×33)	33	—	Canada	III Unit
8.	RAPP (1×220)	200	—	Canada	II Unit.
	MAHARASHTRA				
9.	Vir Hydro (2×4·5)	9	—	Hungary	
	ORISSA				
10.	Balimela (3×60)	180	—	USSR	I, II & III Units.
	UTTAR PRADESH				
11.	Obra Thermal Extn. (2×100) . . .	—	200	BHEL	II & III Units.
12.	Yamuna II (4×60)	—	240	HEL	I, II, III, & IV Units.
13.	Ramganga (1×60)	—	60	HEL	I Units.
	WEST BENGAL				
14.	Santaldih (2×120)	—	240	HEL	
	DELHI				
15.	Badarpur (3×100)	—	300	BHEL	I, II, & III Units.
	HIMACHAL PRADESH				
16.	Giri Bata (2×30). . . .	—	60	BHEL	
	D. V. C.				
17.	Chandrapura (2×120) . . .	—	240	HEL	I & II Units.
	PUNJAB				
18.	U.B.D.C. (1×15)		15	HEL	III Unit.
	TRIPURA				
19.	Gumti (2×5)	—	10	HEL	
	TOTAL	52 + 1871	= 2423		

Source	*Capacity (MW)*
(*a*) Imported	552
(*b*) Indigenous	1871
(*i*) HEL	1082
(*ii*) BHEL	789

TABLE 1-4

GENERATING UNITS SCHEDULED FOR COMMISSIONING DURING IV PLAN
1973-74

Sl. No.	Name of Project	Capacity: Imported.	Capacity: Indigenous	Country of Import/Name of the Manufacturer	Remarks
1	2	3	4	5	6
	BIHAR				
1.	Subernarekha (1×65)	—	65	BHEL	I Unit.
2.	Patratu Extn. (2×110)	—	220	BHEL	
3.	North Bihar Thermal (1×110)	—	110	BHEL	
	GUJARAT				
4.	Ukai Hydro (1×75)	—	75	HEL	IV Unit.
5.	Ukai Thermal (1×120)	—	120	HEL	I Unit.
	HARYANA				
6.	Faridabad Exten. (1×55)	—	55	BHEL	
	KERALA				
7.	Idikki (1×130)	130	—	Canada	II Unit.
	MAHARASHTRA				
8.	Bhatgar (1×16)	—	16	BHEL	
9.	Vaitarna (1×60)	—	60	BHEL	
10.	Koradi (2×120)	240	—	Poland	
11.	Koyna III (4×80)	—	320	HEL	
	MYSORE				
12.	Sharavathi III (2×89·1)	—	178·2	HEL	
	NAGALAND				
13.	Dzuza Hydro	—	1·5	Indigenous	
	ORISSA				
14.	Balimela (3×60)	180	—	USSR	IV, V & VI Units.
	PUNJAB				
15.	Beas Unit I (1×165)	—	165	HEL	
16.	Bhatinda (1×110)	—	110	BHEL	I Unit.
	TAMIL NADU				
17.	Kundah IV (1×60 + 1×50)	—	110	BHEL	
18.	Ennore Extn. (1×110)	—	110	BHEL	
19.	Kalapakkam (1×200)	—	200	HEL	
	UTTAR PRADESH				
20.	Ramaganga (1×60)	—	60	HEL	II Unit
21.	Yamuna IV (1×10)	—	10	BHEL	I Unit.
22.	Harduaganj/Panki Extn. (2×110)	—	220	BHEL	
	HIMACHAL PRADESH				
23.	Baira Siul (3×66)	—	200	BHEL	
	TRIPURA				
24.	Loktak (2×35)	—	70	BHEL	
	TOTAL	550 +	2475·7		

	MW
Imported	550·0
Indigenous	
HEL	1,118·2
BHEL	1,356·0
Jyoti Ltd.	1·5
TOTAL	3,025·7 MW

TABLE —2

LENGTHS OF TRANSMISSION LINES INDIA
(33 KV and above)
(in thousands of circuit km.)

YEAR	Voltage in kv			
	33/44	66	110/132	220/230
1955	7·5	7·8	7·4	—
1956	9·4	8·7	7·9	—
1957-58*	12·0	8·4	11·3	—
1958-59	13·8	9·4	11·5	—
1959-60	15·1	11·3	12·5	—
1960-61	19·5	12·8	12·8	1·1
1961-62	20·1	13·1	13·3	1·1
1962-63	23·7	13·9	17·6	1·2
1963-64	27·5	15·1	18·5	2·1
1964-65	33·9	15·9	23·2	2·5
1965-66	40·7	17·5	24·7	3·8
1966·67	46·6	18·9	26·4	4·6
1967-68	52·7	19·6	31·0	6·4
1968-69	57·7	21·2	34·0	10·2

*For 15 months (from January, 1957 to March, 1958).
Figures show line lengths at the end of the years.

TABLE—3

STATEMENT SHOWING THE IMPORVEMENT NECESSARY IN THE DELIVERY SCHEDULE OF HEAVY ELECTRICALS LTD. TO COMMISSION THE UNITS AS PER SCHEDULE

Name of Project/ State	Unit No.	Unit Capacity in MW	Commissioning target date	Delivery completion date exfactory (as indicated in may, 1970)	Imporove-ment neces-ssary in months	Remarks
1	2	3	4	5	6	7
GENERATING THE UNITS TARGETED FOR LATER PART OF 1971-72.						
1. Yamuna II (UP)	II	60	Dec.'71	Sep.' 71	6	
2. Chandrapura (DVC)	I	120	Marc.'72	Feb.'71	12	
GENERATING UNITS TRAGETED FOR 1972-73.						
3. Ukai Hydro (Gujarat)	I	75	May.'72	Jun.' 72	14	
	II	75	Aug.' 72	Oct.' 72	11	
	III	75	Jan.' 73	Mar. ' 73	12	
4. Yamuna II (UP)	III	60	Jun.' 72	Dec. ' 71	7	
	IV	60	Mar. ' 73	Feb. '72	5	
5. Ramganga (UP)	I	60	Mar. '73	Oct. '72	15	
6. Chandrapura (DVC)	II	120	Mar. '73	Apr. '72	4	
GENERATING UNITS TARGETED FOR 1973-74.						
7. Ukai Hydro (Gujarat)	IV	76	Apr. '73	Jun. '73	8	
8. Ukai Thermal (")	I	120	Mar. '74	Not indicated		Delivery to be completed by 1972-73.
9. Koyna III (Mah.)	III	60	Dec. '73	Oct. '72	4	
10. Beas Unit I (Punjab) (Dehar)	I	165	Jun. '73	Sep. '72	15	
11. Ramganga (UP)	II	60	Mar. '74	Apr. '73	13	

TABLE 4.

STATEMENT SHOWING THE IMPROVEMENT NECESSARY IN THE DELIVERY SCHEDULES OF BHARAT HEAVY ELECTRICALS LTD. TO COMMISSION THE UNITS AS PER SCHEDULE

Name of Project/State	Unit No.	Units Capacity in MW	Commissioning target date	Delivery Completion date- ex-factory (as indicated in May,70	Improvemant necessary in months	Remarks
1	2	3	4	5	6	7
GENERATING UNITS TARGETED FOR 1972-73.						
1. Obra Thermal Extn. (UP)	II	100	Apr. '72	Oct. '71	6	
GENERATING UNITS TARGETED FOR 1973-74.						
2. Subernrekha (Bihar)	I	65	Dec. '73	Mar. '73	6	
3. North Bihar Thermal(Bihar)	I	110	Mar. '74	Not indicated		Delivery to be completed by 1972-73
4. Bhatagar Hydro (Mah.)	I	16	Jun. '73	Dec., '72	6	-do-
5. Vaitarna Hydro (Mah.)	I	60	Dec. '73	Mar. '73	6	-do-
6. Kundah IV (Tamil Nadu)	I	60	Dec. '73,	Not indicated		Delivery to be completed by 1972-73.
	I	50	Mar. '74	Not indicated		
7. Ennore Extn. (Tamil Nadu)	I	110	Dec. '73	Not indicated		-do-
8. Yamuna IV (UP)	I	10	Mar. '74	Mar. '73	6	
9. Panki/Harduagang Extn (UP)	I	110	Mar. 74	Not indicated		Delivery to be completed by 1972-73
	II	110		—do—		
10. Baira Suil (HP)	I	66	'72	Jun. '73	12	
	II	66	Mar. '74	Dec. '73	15	
	III	66		Jun. '74	18	
11. Loktak (Manipur)	I	35	Mar. '74	Dec. '73	15	
	II	35		Jun. '74	18	

TABLE—5

GENERATION STATISTICS

CENTRAL, ELECTRICITY GENERATING BOARD OF U.K.

INSTALLED CAPACITY AND VOLUME OF ADDITIONS

Year	No. of Power Stations in commission at the end of the year	Generating Plants at the end of the year		New Plants commissioned during the year		New Plants under construction or Planned at the end of the year	
		Installed capacity of steam (Conventional) MW	Nuclear	Generating sets (installed capacity MW	Reactors	Generating sets (installed capacity MW	Reactors
1	2	3	4	5	6	7	8
1958-59	238	25,240	—	1,205	—	12,564	9
1959-60	234	27,444	—	2,355	—	11,494	9
1960-61	230	29,087	—	1,780	—	12,893	11
1961-62	233	30,888	—	1,927	—	15,346	13
1962-63	236	32,983	709	2,951	4	20,146	10
1963-64	233	34,482	709	1,485	—	25,030	11
1964-65	233	34,700	1,349	1,361	2	31,416	10
1965-66	230	35,800	2,823	3,063	5	22,788	6
1966-67	226	36,916	3,068	2,042	1	29,175	6
1967-68	216	39,939	3,314	4,121	1	27,477	7

SOURCE: C.E.G.B. Annual Report 1967-68.

TABLE 6

PLAN EXPENDITURE IN POWER SECTOR

Sub-Head-Wise	1st Plan		2nd Plan		3rd Plan	
	Provision	Actual	Provision	Actual	Provision	Actual
1	2	3	4	5	6	7
Generation	—	—	235	250	712	774
Transmission and Distribution	—		117	115	222	301
Rural Electrification** . . .	—	—	75	75	105	153
Miscellaneous:	—	—	—	20	—	24
TOTAL	260	260	427	460	1039	1252

**In recent years the physical achievements of rural electrification have exceeded the targets set in making Plan provisions.

Source : Planning Commission

Table 6 (*Contd.*)

PLAN EXPENDITURE IN POWER SECTOR (*Contd.*)

(Rs. in crores)

1966-67		1967-68		1968-69		1970-70	1969-71
Provision	Actual	Provision	Actual	Provision	Actual	Provision	Provision
8	9	10	11	12	13	14	15
216	240	233·18	221·3	184·29	215·7	217·94	284
80	83·2	92·79	103·2	104·29	105·5	95·71	127
44	734	55·25	74·8	47·73	88·7	50·36	66
—	7·2	4·55	6·6	3·38	4·7	3·06	5
340	403·4	385·77	409·9	339·69	414·6	367·07	482

LIST OF FIGURES

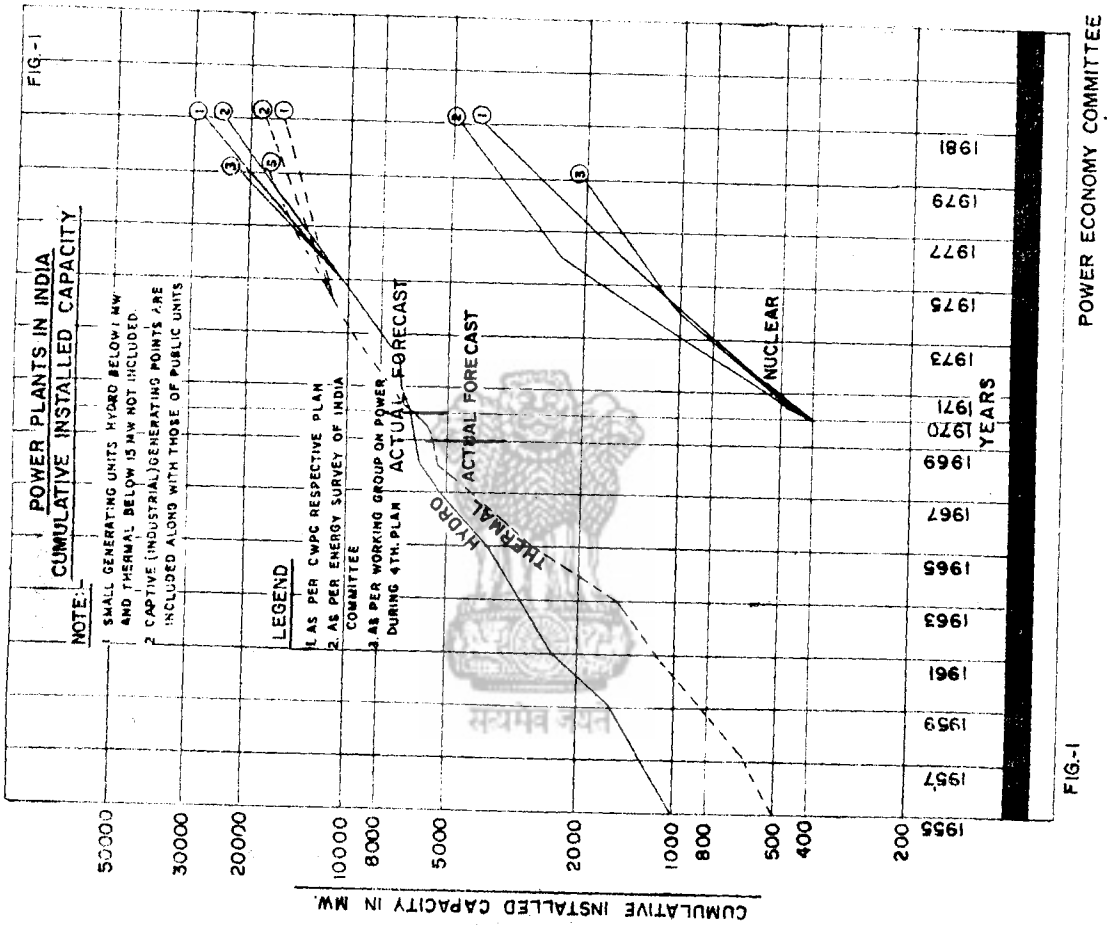


FIG-1
POWER PLANTS IN INDIA
CUMULATIVE INSTALLED CAPACITY
NOTE:-
1 SMALL GENERATING UNITS HYDRO BELOW 1 MW AND THERMAL BELOW 15 MW NOT INCLUDED.
2 CAPTIVE (INDUSTRIAL) GENERATING POINTS ARE INCLUDED ALONG WITH THOSE OF PUBLIC UNITS
LEGEND
1. AS PER CWPC RESPECTIVE PLAN
2. AS PER ENERGY SURVEY OF INDIA COMMITTEE
3. AS PER WORKING GROUP ON POWER DURING 4TH. PLAN
ACTUAL
FORECAST
HYDRO
THERMAL
NUCLEAR
CUMULATIVE INSTALLED CAPACITY IN MW.
50000
30000
20000
10000
8000
5000
2000
1000
800
500
400
200
1955
1957
1959
1961
1963
1965
1967
1969
1970
1971
1973
1975
1977
1979
1981
YEARS
POWER ECONOMY COMMITTEE
FIG.-1

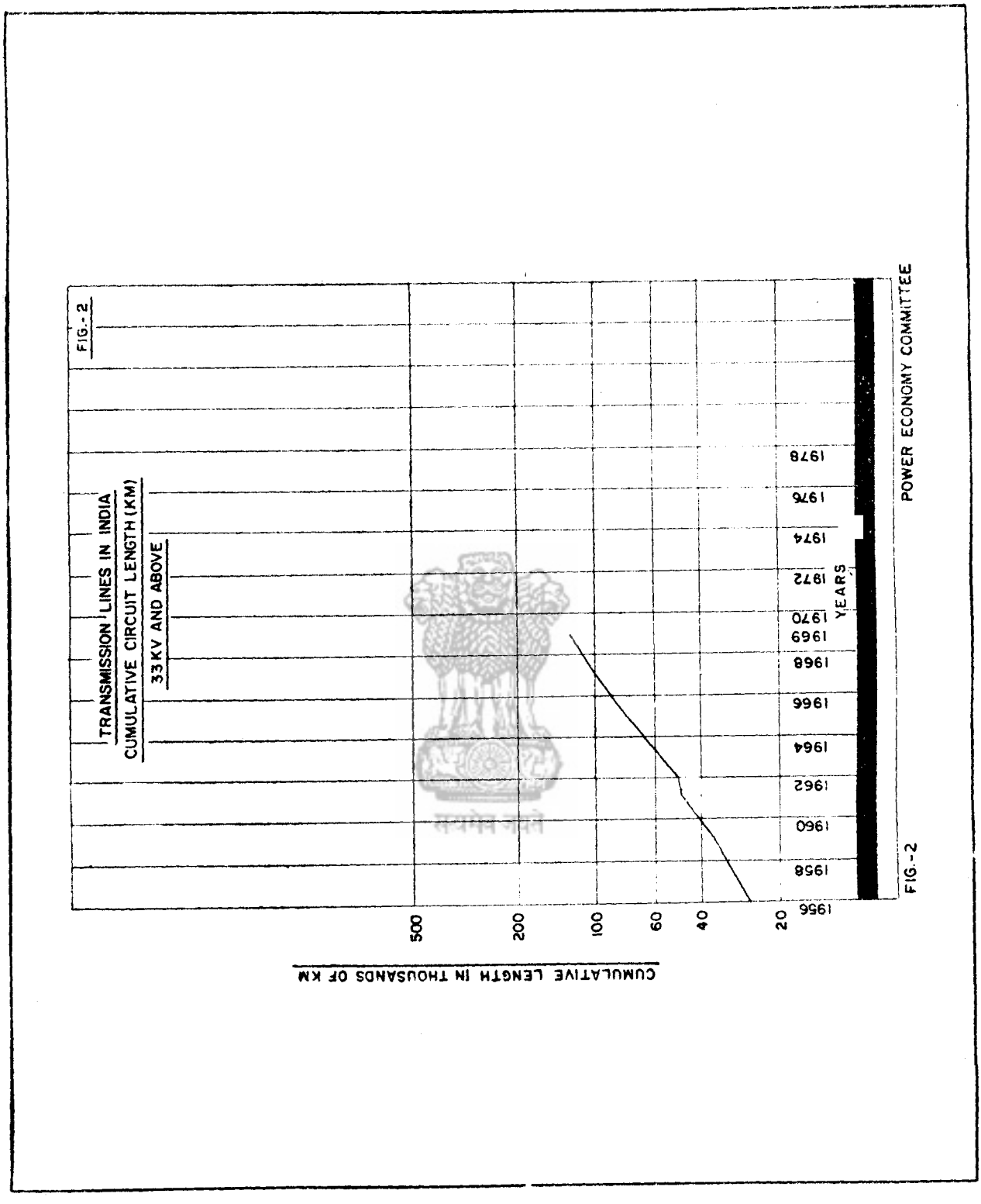


FIG.-2
TRANSMISSION LINES IN INDIA
CUMULATIVE CIRCUIT LENGTH (KM)
33 KV AND ABOVE
CUMULATIVE LENGTH IN THOUSANDS OF KM
500
200
100
60
40
20
1956
1958
1960
1962
1964
1966
1968
1969
1970
1972
1974
1976
1978
YEARS
POWER ECONOMY COMMITTEE
FIG.-2

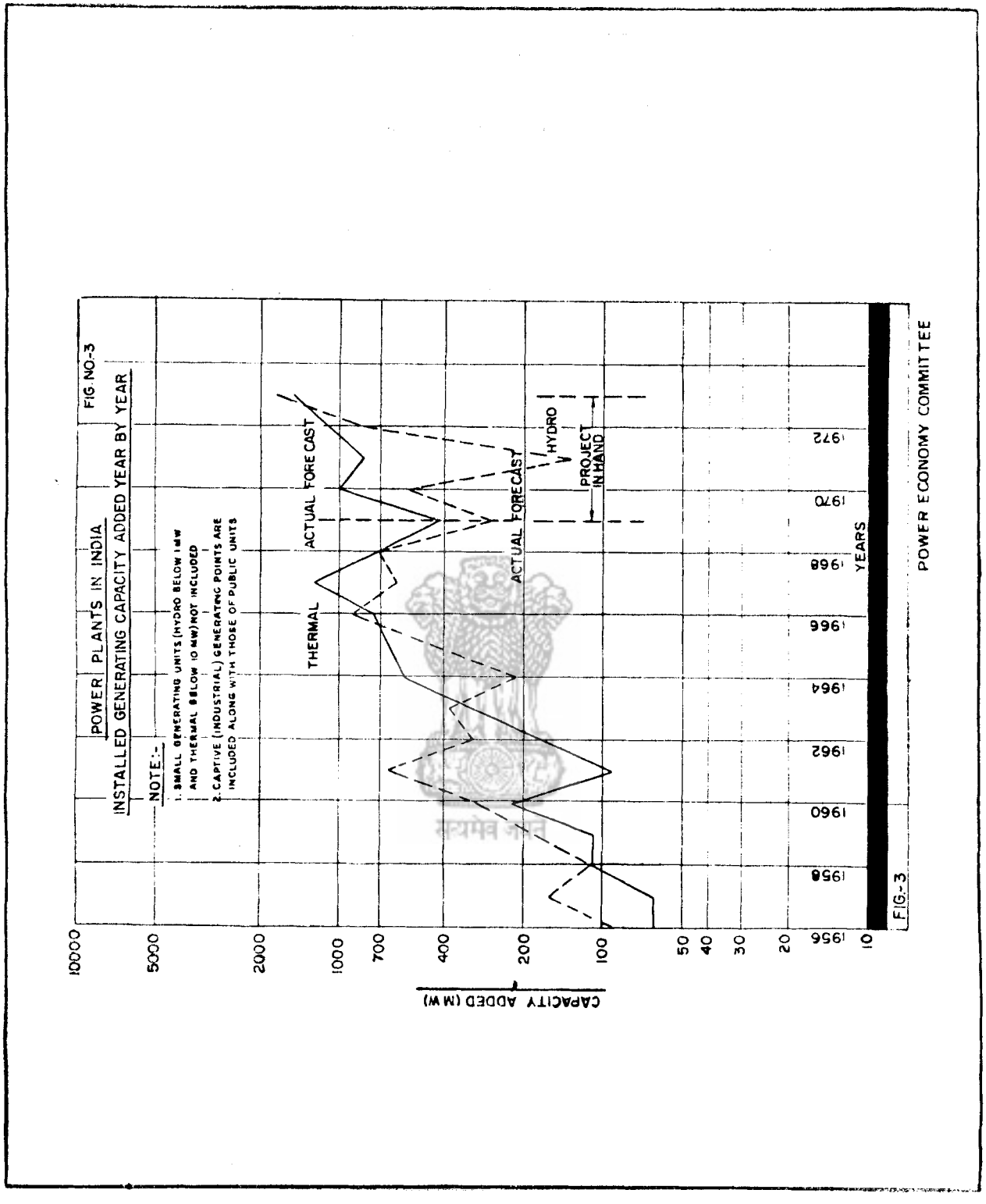


FIG.NO-3
POWER PLANTS IN INDIA
INSTALLED GENERATING CAPACITY ADDED YEAR BY YEAR
NOTE:-
1. SMALL GENERATING UNITS (HYDRO BELOW 1 MW AND THERMAL BELOW 10 MW) NOT INCLUDED
2. CAPTIVE (INDUSTRIAL) GENERATING POINTS ARE INCLUDED ALONG WITH THOSE OF PUBLIC UNITS
THERMAL
ACTUAL FORE CAST
ACTUAL FORECAST
HYDRO
PROJECT IN HAND
CAPACITY ADDED (MW)
10000
5000
2000
1000
700
400
200
100
50
40
30
20
10
1956
1958
1960
1962
1964
1966
1968
1970
1972
YEARS
FIG-3
POWER ECONOMY COMMITTEE

LIST OF APPENDICES

APPENDIX-1

RESOLUTIONS PASSED AT THE 4TH CONFERENCE OF CHAIRMEN OF THE STATE ELECTRICITY BOARDS HELD IN NEW DELHI IN APRIL, 1970

1. *Measures to be taken for expediting the commissioning of power stations according to Schedule.*

The Fourth Conference of Chairmen of State Electricity Boards discussed the measures to be taken for expediting the commissioning of power stations which were scheduled to be commissioned in 1969-70 and for commissioning power stations which are scheduled to be commissioned in 1970-71. The Conference notes that a Committee had been set up in the Ministry of Irrigation and power for reviewing periodically in detail the progress made in the placement of orders and manufacture of generating equipment and also to co-ordinate the progress of manufacture with the progress of civil works in the various power projects under execution in the country. The Conference further notes that Members of the Central Water and Power Commission have been ear-marked for giving assistance to the Project authorities in respect of those power projects which are scheduled to be commissioned in 1970-71. The Conference resolves that full co-operation should be extended by the project authorities to the Members concerned of the Central Water & Power Commission and their assistance taken in order to ensure that power projects are commissioned according to schedule. The Conference further resolves that the power projects to be commissioned in 1971-72 also should be entrusted to individual members of the Central Water and Power Commission immediately to ensure commissioning according to schedule.

2. *Evaluation of Indigenous Generating Capacity.*

The Fourth Conference of Chairmen of State Electricity Boards notes that 6.48 million kW of installed generating capacity to be commissioned has been tied up with indigenous manufacturing capacity. The Conference further emphasises that it is essential that such equipment is delivered in time so that power stations are commissioned according to schedule. In view of the delays that have taken place in supply of generaing equipment, particularly in respect of hydel projects, the Conference suggests that an urgent examination should be made of the capacity of the indigenous manufacturing industries to supply the generating equipment in time so the remedial measures could be taken to meet shortfall in the supply of equipment. The Conference, therefore, resolves to constitute a Committee for this purpose as follows :—

1. Vice-Chairman, CW&PC	Chairman.
2. A representative of the Planning Commission	Member.
3. Chairman, H. E. L.	Member.
4. Chairman, BHEL	Member.
5. Jt. Secretary, Ministry of Industrial Development	Member
6. Chairman, U. P. State Electricity Board	Member.
7. Chairman, Andhra Pradesh State Electricity Board	Member.
8. Director (P & P) , CW&PC	Member-Secretary.

The Committee would examine the capability of the indigenous manufacturing units to deliver the generating plant according to requirements during the Fourth and Fifth Plans and suggest measures to meet the anticipated shortfalls.

3. *Supply of Essential Materials for Power Schemes*

The Fourth Conference of Chairman of State Electricity Boards notes with concern the scarcity of raw materials for implementation of power programmes, particularly rural electrification. The Conference further observes that there is acute shortage of E.C. Grade aluminium, high carbon steel, CRGO laminations, M. S. rounds and plates, structural steel etc. Measures have already been initiated by the Ministry of I&P and the other concerned ministries for improving the supplies of these raw materials by imports and also for fixing the prices. The Conference resolves that indents for the supply of these raw materials should be co-ordinated by the Ministry of Irrigation and Power and the C.W.&P.C. and that measures be devised to ensure that quotas of essential raw materials are arranged to match the demands of the State Electricity Boards. The Conference also suggests that the quotas of essential raw materials, as far as possible, be allocated to State Electricity Boards which in turn would sub-allocate these quotas to the manufacturers including industries on whom orders have been placed by the State Electricity Boards.

783 I&P/71—7

APPENDIX-2

EXTRACTS FROM REPORT OF THE COMMITTEE ON SHORT-FALL IN GENERATION DURING III PLAN

4.1. *General Observation*

From the project performance data annexed to this report, several pertinent points seem to emerge as follows :—

4.1.1. Out of 16 thermal and 10 hydro projects (aggregate capacity 4.828 million KW), the performance of which has been studied by the Committee, advance authorisation or formal sanction for 11 thermal projects was issued between April, 1959 and September, 1961 and for five thermal projects, between September, 1961 and June, 1963. The foreign exchange for the first group was tied up between January, 1960 and May, 1963 and that for second between January. 1962 and May, 1963. The inclusion of the second group (aggregating 725MW) in the Third Plan target decided in September. 1961 would appear somewhat unrealistic and *ab initio* some element of doubt was introduced as to the feasibility of implementation.

4.1.2. Delay in issuing appropriate sanction to the project results in pushing back all the subsequent processes and ultimately the commissioning date. Such delay was seen to occur due to (1) Prolonged correspondence between CWPC and State authorities for clarification of project details and (2) routine to be followed in obtaining clearance for the project. Both would seem controllable as discussed hereinafter.

4.1.3. At the time of submission of the project report, the emphasis was generally on the justification of the project in the context of increased power demand and some indications of foreign exchange requirement and the financial results showing the viability of the project. In several cases project reports were received with inadequate details and approved. Such projects sanctioned without adequate investigation were delayed during process of execution. In case of hydro projects, inadequate investigation often resulted in major changes in the scope of work and design which meant considerable delays.

4.1.4. A large time lag between advance authorisation and foreign exchange tie-up had in several cases resulted in delayed beginning or at least slow progress during the initial stages. Project authorities were found to be somewhat reluctant or unable to proceed fast until the project was firmly tied up in all respects. Administrative sanction and adequate provision of funds were also another factor which caused slow progress during the initial stage.

4.1.5. Timely appointment of a competent consultant for thermal projects had manifestly benefited the project authorities particularly those who were not suitably organised in this field, in that, all phases of the project work were carried out in a systematic manner. On the other hand, delayed appointment had adversely affected the programme. The absence of a suitable Indian Organisation under the consultants also delayed the programme.

4.1.6. The compexity of procurement routine from the issuance of tender specification to the issuance of import licence or opening of letter of credit, which had a bearing on the delivery of equipment, had in many cases upset even a preplanned construction schedule. The adverse effect was more pronounced in cases where procurement of different equipment was arranged from different sources.

4.1.7. Lack of vigilance on follow-up actions in the field of co-ordination between various agencies, programming and scheduling, shipment, customs clearance, despatching and replacement against transit losses and damages caused considerable delays. It is inferred that in many cases the organisation was not suitably equipped.

4.1.8. Due to interdependence of design, procurement and field construction, there was the imperative need for mapping out all complementary actions in sufficient details and in advance to avoid hold-ups in various phases of the work. A detailed schedule of this type was found missing in many cases, particularly in aided projects obtaining all the imported equipment from one source. Complete dependence on foreign suppliers was observed and their lapses resulted in delays.

4.1.9. Construction of different projects progressed differently and the causes of delays had also varied rather widely—from delay in sanctioning the project to delay arising out of emergency conditions due to Chinese aggression or conflict with Pakistan. Not all of them, however, affected the end point. Parallel actions or operations were possible with the result 9 months' delay in any particular item ultimately reflected in a month's delay in the commissioning data. There were, however, steps which, if once delayed, continued to effect successive sanctions down the line resulting ultimately in delay in commissioning. For the purpose of achieving the target, such steps deserved anticipation and timely action.

4.1.10. In case of thermal projects, once the major civil works at site commenced, the field construction appeared to progress more or less in an orderly manner, subject to certain variations which could generally be predicated within limits. In other words, from this stage, the project came under reasonable control of the construction organisation and its course became defined. The position was not quite so during the pre-construction stage in which several agencies were involved. This point of time viz. commencement of major civil works at site could be considered as a distinct dividing line of the total project implementation period for two broad phases of the project.

4.1.11. Out of 16 thermal projects studied, the first unit at Neyveli Stage II (50 MW) was commissioned in 26 months from the date of commencement of major civil works at site. This was a repeat unit and manufacture had started in advance. This accounted for the short period indicated. The second unit (100MW) in the same power station would require 46 months (likely commissioning date April, 1967). The actual construction period for commissioning of the first unit in nine project (vide Appendix 12) varied between 31 and 39 months although the variation in the first phase was wider. The corresponding period for the remaining six projects had varied between 40 and 48 months. The extension of the construction period in case of the latter group was mainly due to (1) reasons beyond control of the project authorities (2) delayed actions in the first phase and (3) unforeseen difficulties (natural hazards, was situation and the like). There was considerable time-lag between commissioning of the first unit and that of the second and subsequent units. In several cases the reasons were somewhat beyond the control of the project authorities. Cannibalisation to complete the first unit out of the other due to delayed receipt of replacement against transit losses or damage, resulting from the cumbersome procedures or failures of vital components during the trial period of subsequent units or labour strikes are typical examples of such delays. On the other hand in some of the projects, the reasons for delay in commissioning the second unit appear controllable. Time taken for strengthening the depleted construction organisation due to diversion of construction personnel to operation, delayed action by Project Authorities in obtaining statutory licences for explosive, clearance from Electrical Inspectors, etc. are examples of the latter type of delays.

4.1.12. On the hydro side, the period of construction at site varies between 5 and 7 years. The variation in the period for the first phase was even wider. In most of the cases the delays during the construction period could be directly or indirectly attributed to inadequate investigation, particularly geological investigation and firm design of civil engineering works apart from other reasons mentioned earlier.

4.2. *Causes of Delays*

4.2.1. The various causes of delays as observed in the implementation of Third Plan Schemes are listed below separately for thermal and hydro projects :—

i. *Thermal*

1. Lack of adequate project data.
2. Inadequate investigation before finalising technical project report.
3. Major change in scope of work.
4. Delay in site selection and land acquisition.
5. Delay in issue of authorisation by Central and/or State authorities.
6. Delay in foreign exchange tie up.
7. Deficiency in organisation for planning and engineering the project.
8. Delay in appointment of consultants wherever required.
9. Lack of local organisation of consultants resulting in delay in communicating decision.
10. Delay in procurement of equipment due to—
    (a) late issue and late finalisation of tenders.
    (b) procedural delay in processing through D.G.S. & D.;
    (c) processing of foreign exchange release by Govt. of India.
11. Delay in levelling and dressing at site due to—
    (a) inaccessible nature of site.
    (b) delay in procurement of construction equipment.
12. Late receipt of erection drawings.
13. Delay in procurement of construction equipment like tower crane, Gantry crane etc.
14. Shortage of Cement and Steel, welding rods, explosives etc.
15. Late arrival of erection specialists.
16. Delay in delivery of equipment due to—
    (a) failure of supplier to keep up schedule
    (b) lack of ships, port strikes etc.
    (c) impounding of equipment in Pakistan.
17. Difficulties in transporting equipment to site—
    (a) in moving over dimensional packages on railway due to restrictions imposed by bridges, tunnels etc.
    (b) Due to lack of suitable rolling stock, etc.

(c) Due to difficult terrain and lack of proper access routes.

18. Delays in getting replacement for items of equipment damaged or lost in transit.

19. Lack of proper planning and co-ordination of various construction schedule and failure to anticipate delay in case of critical phase of construction activity in advance.

20. Labour strikes and civil disturbances.

21. Unprecedented rains and floods.

22. Difficulties experienced due to change in the course of lean water flow in river.

23. Change in top personnel in the course of implementation of project.

24. Stoppage of work due to enemy action.

II. *Hydro*

1. Inadequate investigation before finalising technical project report.

2. Major change in the scope of work like :
   (a) change in the location of dam;
   (b) change in design of dam foundation;
   (c) change in design of Water Conductor System;
   (d) change in location of power station and switch yard;
   (e) change in generator capacity.

3. Delay due to inter-State aspects.

4. Delay in issue of authorisation by Central and/or State authorities.

5. Delay in foreign exchange tie-ups.

6. Change in key personnel in the course of advance planning and execution.

7. Delay in procurement of equipment due to—
   (a) late issue and late finalisation of tenders.
   (b) procedural delays in processing through DGS&D.
   (c) processing of foreign exchange release by Government of India.

8. Delay in procurement of construction equipment.

9. Shortage of Cement and Steel, welding rods, explosives, etc.

10. Shortage of spare parts for construction equipment.

11. Late arrival of erection specialists.

12. Delay in delivery of equipment due to failure of supplier to keep up schedule.

13. Difficulties in transporting equipments to site—
   (a) in moving over dimensional packages on railway due to restrictions imposed by bridges, tunnels, etc.
   (b) Due to difficult terrain and lack of access roads.

14. Unprecedented rains and floods.

15. Land acquisition and rehabilitation.

15. Having reviewed the various areas of delays in project implementation, the Committee would recommend as follows :—

5.1.1. A close scrutiny of the status of the projects included in any plant should be made before formulation of each Five Year Plan, with a view to fixing a realistic target which would reasonably be expected to be achieved.

5.1.2. By and large, inadequate investigation could delay the various phases of the project and as such greater importance should be attached to this aspect. No project should be sanctioned unless it was fully investigated. This would only mean that with a longer lead time prior to the sanctioning of the project but with appropriate planning in this direction, it would be possible to match up this part of the work for implementation of the project during a particular plan period.

5.1.3. Since the investigation work for the hydro scheme is much more extensive, it would need a greater degree of collaboration between Centre and State in case of very large and inter-State projects to complete this part of the work in time. The investigation work for hydro projects should be placed under the charge of experienced engineers not below the rank of a Superintending Engineer. In this context a master plan for Hydro projects should be worked out. Similar principles should also be applied to Thermal Projects but the detailed work associated with thermal schemes might be left to the care of States. It would be necessary for the CWPC to take the initiative and maintain a close liaison with the States during investigation and preparation of master plans.

5.1.4. One of the reasons for delay in sanctioning a project is an inadequate project report submitted by the States. Such reports should give full account of the investigations carried out, major technical details, fund required, indication of construction materials and equipment together with a schedule of action and programme of construction, existing organisation and the need to augment it, brief details of utilisation of power etc. This will be in addition to the information usually given regarding power demand, financial results etc. The Planning Commission have already circulated a proforma, guide line for preparation of project report. As C.W.P.C. will be the official examining body, the proforma already circulated should be reviewed by them and amended as necessary to obtain fuller information in respect of thermal and hydro projects.

5.1.5. The Committee has observed that considerable time is being taken at present in giving approval to the project by the concerned Departments at the Centre and State. According to the present procedure, the State Governments are required to submit detailed project reports to the Central Water and Power Commission, Ministry of Irrigation and Power and the Planning Commission for examination and approval. On the basis of such examination, the CWPC submits its comments to the Technical Advisory Committee set up by the Planning Commission on the merits of individual projects. In a number of instances the Committee noted that prolonged correspondence and consultations between CWPC and the State Project authorities had resulted in delayed submission of comments for consideration by the Technical Advisory Committee, which is mainly due to inadequate data and information in the project report. The Committee noted that although a representative of the Deptt. of Co-ordination (Ministry of Finance) was coopted on the Advisory Committee yet all new projects estimated to cost Rs. 5 crores and above though recommended by the Advisory Committee were again referred to that Department by the Planning Commission for getting its clearance before giving its approval. The Committee fails to appreciate the utility of the second reference to the Department of Coordination. The Planning Commission's approval should be issued as soon as a project is recommended by the Technical Advisory Committee.

5.1.6. In order to encourage detailed investigations as envisaged, adequate funds should be allocated in each Plan for investigation of hydro and thermal projects. Investigation of thermal schemes in advance should be given greater consideration. Association of consultants from this stage particularly in thermal projects would be an expediting measure.

5.1.7. The tie-up foreign exchange, if involved and for which an indication should have been given in the project report should be communicated to the project authority without a large time-lag it was often seen that active work on the project was not taken up until this was formally advised.

5.1.8. The commencement of civil work of some of the projects was delayed due to late ordering of construction material like steel, cement, etc. The Committee is of the opinion that there cannot be any valid reason for the lapse on the part of the project authorities. The requirement of such materials can be estimated and included even in the project report and procurement action can be initiated as soon as the project is formally sanctioned. Proper co-ordination in this regard can be achieved between CWPC and the project authorities for early supply. Often the work was held up due to non-receipt of special steel sections and plates. With close vigilance and co-ordination, it may be possible to minimise delay on this account, if not obviate them altogether.

5.1.9. The procurement procedures have seriously affected the construction programme and hampered construction progress in many vital projects. There is scope for streamlining the procedure so as to avoid delay in the construction programme. There are many aspects involved in the procurement procedure. One of them is the agency for purchases. The study made in this connection is given hereunder.

5.1.10. The purchase of equipment has generally been handled by one of the two agencies *viz.*, (1) Project authority itself (2) Central agency like the D.G.S.&D. The time taken for the purchase action in all cases can be divided into two broad stages, the first stage commencing from the time of issue of tender enquiry or the time of placing the indent on D.G.S.&D. to the time of issuing a letter of intent on the prospective supplier, and second stage comprising the time taken from the issue of letter of intent to the issue of import licence/letter of credit, which has a bearing on the deliveries.

6. *Time Schedule and Model Programme*

6.1. As already stated, the entire process of execution of the project from its conception to the commissioning falls into two distinct phases. The first one from the conception to the commencement of construction of major civil works at site and the second one comprising construction, testing and commissioning. The second phase of the work is actual field construction whereas the first phase comprises of various sanctions, approvals, Engineering coordination, procurement etc., which have to precede the productive phase. The activities of the first phase generally comprise the following:

1. Approval of the project by the Central Government.
2. Allocation of funds and administrative approval of the project.
3. Tying up of foreign exchange sources.
4. Preparation of specification and invitation of tenders.
5. Land acquisition where necessary.
6. Tender invitation scrutiny and issue of letter of intent and contract finalisaton.
7. Clearance from indigenous angle and release of foreign exchange.
8. Issue of import licence.
9. Opening letter of credit wherever necessary.
10. Detailed design which will continue even after the second phase starts.
11. Preliminary works.

The second phase, on the other hand will comprise:

(a) Field construction, civil, mechanical and electrical.

(b) Testing and commissioning.

6.2. In order to ensure smooth and uninterrupted progress of the project, it is of utmost importance to carefully plant in very great detail the numerous complementary activities of the project. These activities have considerable inter dependence on one another and often restrain other activities. A thorough coordination of all these activities is required from the very beginning. It is necessary to foresee these activities and the inter-action of each other to be able to arrive at a rational programme for the execution of the project. For many projects this aspect does not seem to have received due attention during the Third Five Year Plan. The most convenient and effective method of programming is to adopt the PERT network which clearly indicates the inter-action of the various activities and with reasonable durations assigned to them, a very realistic time schedule for the project can be made. This procedure also enables better man-power planning and compression of some of the activity durations to achieve the most expeditious completion of the project. It also enables the project authorities to get a clear perspective view of all the inter-related activities and pin point the critical operations and thus it affords a means to control the progress so as not to materially affect the final completion target. It is recommended that all the project authorities should also adopt this method of programming and controlling the progress.

6.3. From the data received from the various project authorities a study was conducted to determine the range of duration of some of the major activities for the projects. Utilising the findings of this study and keeping in view the problems associated with indigenous industries a model PERT (Programme Evaluation and Review Technique) net-work each for a thermal and hydro project has been drawn up and annexed to this report vide Appendix 16 and 17.

6.4. For thermal project the period of 54 months (vide Appendix 16), reckons from the date of authorisation/formal sanction to the commissioning of the first unit at a new site. A time lag of four months for each successive unit, if all the units have been sanctioned at one time, is normally to be expected. This total period for an extension project will be shorter, the extent of which will depend on the facilities provided in the previous stage of development but it is not likely to make a material difference for the purpose of fixing a plan target. There will be a lead time of about 24 months preceding the sanctioning of the project to cover adequate investigation, preparation of project report and its acceptance at the State level, examination by the Centre and final issuance of formal approval. Thus a total period of 6½ years is to be assumed for purposes of planning.

6.5. On the other hand the time required for execution of a storage hydro project of average complexities is about six years reckoning from the date of authorisation/formal sanction to the commissioning of the first unit. A lead time of two to four years depending on the type of development and topography, preceding the formal sanction of the project is required to cover adequate investigations, preparation of project report and its acceptance at the State level, examination at Centre and final issuance of formal approval. For purposes of planning a total period of 8 to 10 years should be assumed for hydro project of average-complexities. The total period may be longer if the project is an Irrigation-cum-power project or if it involves inter-State problems. In fact, because of possibility of a large variation in the scope of work or in complexities, a model programme is difficult but for purposes of formulation of plans, the period indicated in the annexed PERT network would provide a reasonable basis.

LOAD ESTIMATES AND PLANT PROGRAMMES

Experience of the Central Electricity Generating Board of U.K.
(Extracted from CEGB Annual Report 1967-68)

Load forecasts for the early 1970s have been reduced to take account of the slower growth in the electricity demand which is mainly the result of the general economic slow-down. There is likely to be a substantial margin of plant capacity in 1970-73 unless demand increases considerably in the meantime. The practice of tailoring annual programmes to follow load estimates closely has recently resulted in violent fluctuations in new plant requirements from year to year. A 1 per cent change in the forecasted average annual growth rate changes generating plant requirements six years ahead by some 3,500 MW. If the change is upward, the result is a crash programme of plant ordering and building which is not compatible with optimum economy. If the change is downward, the programme is so reduced as to disrupt both the heavy plant manufacturing resources of the country and the Board's design and construction organisation. This must lead to excessive costs and to long delays when the rate of ordering is again reinstated to an average level.

Excessive swings in plant ordering seriously affect the Board's finances. The effects of overcorrection are likely to be no less serious; if manufacturers are starved of orders for too long, they are unlikely to maintain large specialised facilities and will be forced to cut their losses as best as they can. The generating Board then face a prospect that they will not obtain plant from home sources at the rate of 4,000 MW or 5,000 MW a year, which may well be the level required in the mid-1970s. The resources will not exist and it will take time to re-establish confidence and get them rebuilt.

It is in the Board's interests to ensure that manufacturers are able effectively and efficiently to meet continuing plant construction and maintenance requirements. Although it may not be strictly justified by current load forecasts the Board are therefore anxious to order one new power station in 1968, the first unit to be commissioned in 1973. The advantages to the supply industry as a whole of avoiding a complete gap in the plant programmes are substantial. They are consequently seeking approval to more gradual adjustments to future plant programmes, typing them less closely to changes from year to year in forecasts of future rates of load growth. The implications of ordering one or two new large units in advance of minimum requirements, and bringing forward the retirement of old plant of equivalent capacity, are being examined. The indications are that the savings from the early closure of old and inefficient plant would fully offset the additional capital charges on the new advanced units.

THE CORPORATE MODEL OF AN ELECTRIC UTILITY

1. This is a new technique for future planning. A mathematical model is constructed for the electrical system in question and by the use of computer and simulation techniques in management planning, system engineers and financial managers are given the capacity to predict the effects that future projects are likely to have upon each other and on the overall system operation with a greater degree of certainty. What is even more important, a complete over-view becomes available whereby system planners and financial planners may recognise each other's functions in performing their own tasks. Effective system planners should recognise the economic and financial impact of their alternatives and financial planners would become more aware of the effect of system plans on the future need for funds. With this type of a model available, total corporate planning is facilitated. The model consists of 3 inter-related digital computer programmes—(i) an economic simulation; (ii) a costs simulation (based on power generation expenses) and (iii) an auxiliary nuclear fuel management programme. All corporate activities and certain environmental parameters are represented by the economic simulation. The production costs simulation is designed to supply fuel cost information to the economic simulation and the fuel management programme to supply nuclear fuel scheduling and cost data to both of the other programmes. The corporate models are the digital computer programmes that simulate the operation of a growing power system over the years and translate the results of these operations into economic and financial forecasts. The model permits rapid and relatively inexpensive study of alternate courses of action in the diverse though inter-related areas in which management decisions are required.

2. The Flow Chart shown in Fig. 4-1 indicates the major segments and general structure of the model. Essentially, the structure is that of economic simulation programme. The model utilizes cause and effect relationships to the maximum extent possible to compute expected income and expense items. The economic simulation programme permits forecasting changes in the plant accounts, computing the financing required to support a new plant and calculating both book and tax depreciation.

3. Load data are required to compute production cost and revenues. In the production cost programme, the model is modified to reflect expected contractual purchases and sales of energy and pondage, run-of-river, and pumped storage hydro plant operation. Figure 4-2 shows the structure of the production cost programme. The basic input required includes the system load model, cost and operating characteristics of generating units, contractual obligations for energy sales and purchases and items that define the operating policy. Maintenance is scheduled weekly and fuel expenses accumulated monthly.

3.1. This production cost programme can include a computationally efficient routine that permits representation of the operation of several pumped-storage hydro plants. The technique employed is a constrained gradient method. This insures that the pumped-storage plants operate at the minimum thermal fuel cost while not violating the reservoir storage limitations. The technique starts with the creation of the systems' total thermal cost characteristic curve illustrated at the top of Fig. 4-3. The convex cost function indicates the capacity available during the period, the commitment of units and the economic characteristics of the individual units. Commencing with a full reservoir and no pumped storage plant action, a trial operation is made by assuming that the peak load is to be reduced. This means a reduction in the volume of water in storage. The pumping energy required is equal to the generated power divided by the cycle efficiency. The figure shows how this action results in a net saving in fuel costs.

4. Figure 4-4 illustrates the overall modelling approach used in considering the nuclear units. The fuel management programme converts the fuel design data, cost forecasts for ore fabrication, etc. and forecasts of the operation of the unit into fuel costs for each operating cycle and computes expected reloading dates. The fuel design is fixed so that energy in a given operating cycle remains as specified. Reloadings are then scheduled with assumed loading patterns to meet required energy exposure and fuel costs are developed using the cost data inputted to the fuel management programme. These data are used in the production cost programme to simulate the operation of the units. If the reloading pattern is not fixed, the production cost programme monitors the cumulative energy generated by the nuclear boilers and removes the units when reloading is necessary. When the fuel reloading dates are fixed, the production cost simulation has to assume that the units are similar to pondage hydro plants and generate specified amounts of energy each month.

5. The model of the accounting system transforms the forecasts of cash flows, revenues and expenses into returned net income; and simulates the cash management policies of the firm while executing financial plans, computing income taxes and preparing data for monthly and annual financial reports. Figure 4-5 shows the steps taken each month in the accounting model. The inter-dependence of financing, interest and income taxes requires an iterative computation each month. The calculation starts with preplanned financing and existing interest expenses, and then takes and additional financial needs are computed.

Reference : J. K. Carlin, R. H. Lyons, J. H. Mitiguej, E. F. Murphy, C. D. Galloway, M. A. Sagar, A. J. Wood "Corporate Model of an Electric Utility", IEEE Spectrum June 1969 pp. 75-83.

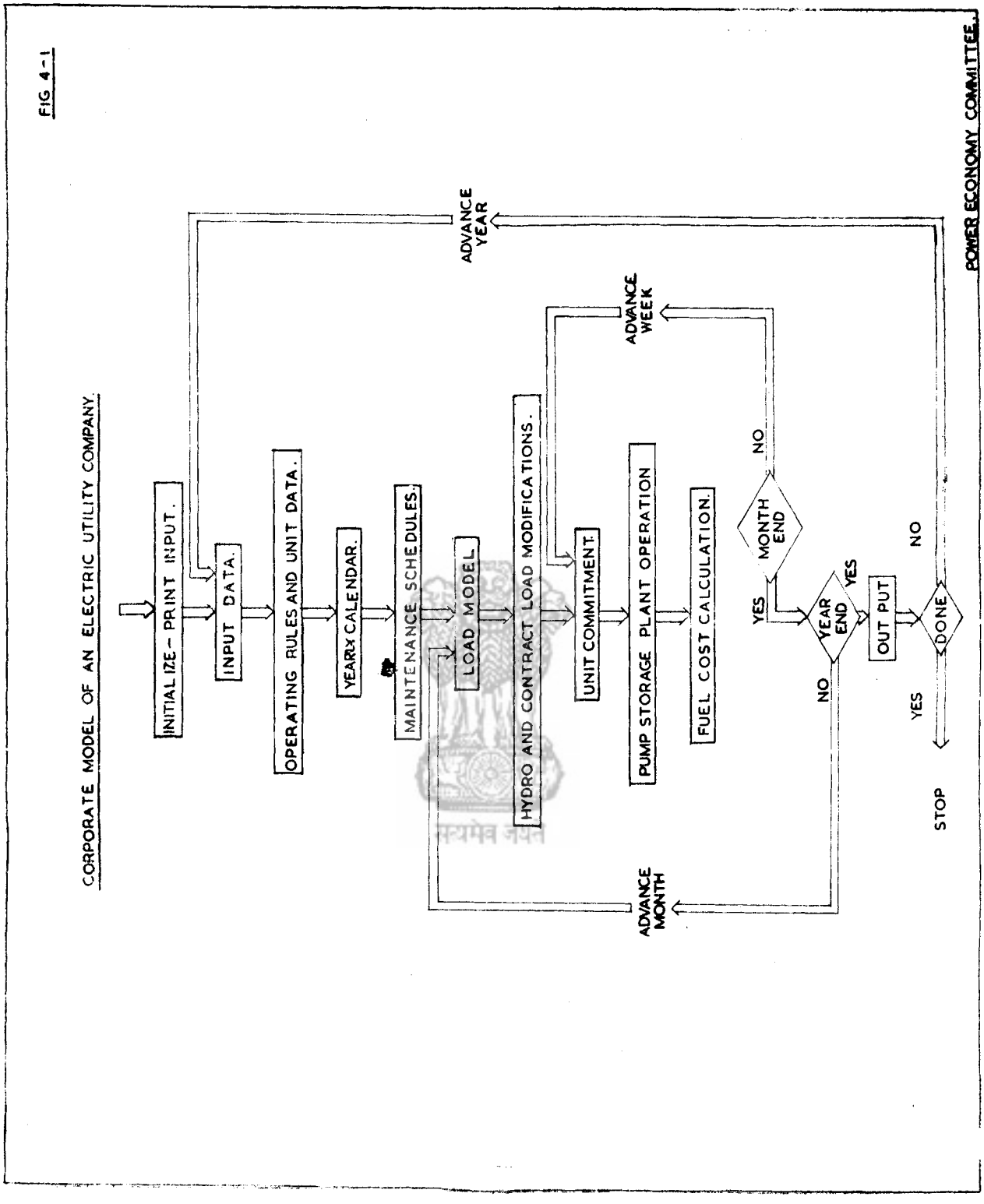
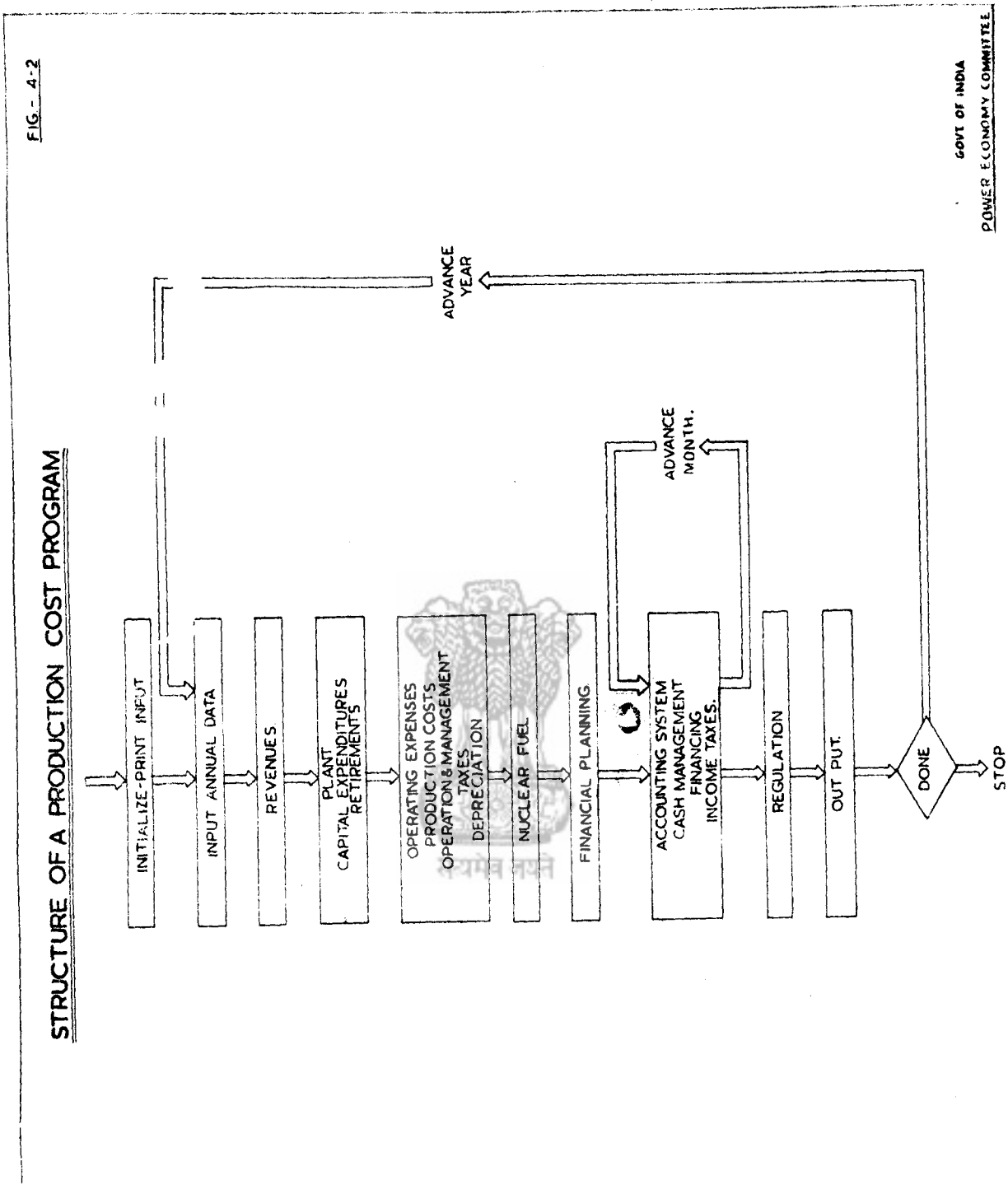


FIG 4-1
CORPORATE MODEL OF AN ELECTRIC UTILITY COMPANY.
INITIALIZE - PRINT INPUT.
INPUT DATA.
OPERATING RULES AND UNIT DATA.
YEARLY CALENDAR.
MAINTENANCE SCHEDULES.
LOAD MODEL
HYDRO AND CONTRACT LOAD MODIFICATIONS.
UNIT COMMITMENT.
PUMP STORAGE PLANT OPERATION
FUEL COST CALCULATION.
MONTH END
YES
NO
YEAR END
YES
NO
OUT PUT
DONE
YES
NO
STOP
ADVANCE WEEK
ADVANCE MONTH
ADVANCE YEAR
POWER ECONOMY COMMITTEE.

FIG - 4-2


STRUCTURE OF A PRODUCTION COST PROGRAM
INITIALIZE-PRINT INPUT
INPUT ANNUAL DATA
REVENUES
PLANT
CAPITAL EXPENDITURES
RETIREMENTS
OPERATING EXPENSES
PRODUCTION COSTS
OPERATION & MANAGEMENT
TAXES
DEPRECIATION
NUCLEAR FUEL
FINANCIAL PLANNING
ACCOUNTING SYSTEM
CASH MANAGEMENT
FINANCING
INCOME TAXES.
REGULATION
OUT PUT.
DONE
STOP
ADVANCE MONTH.
ADVANCE YEAR
GOVT OF INDIA
POWER ECONOMY COMMITTEE

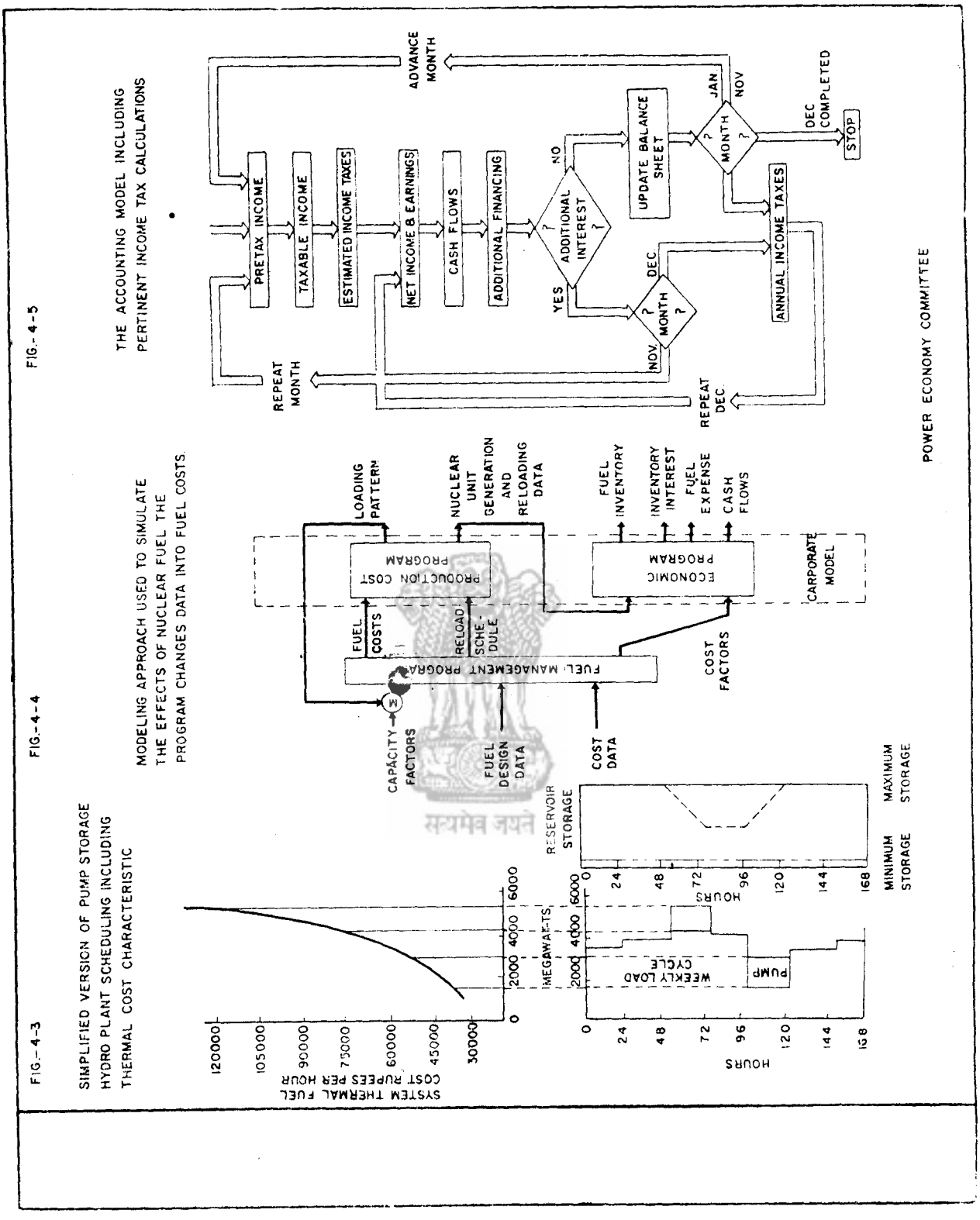


FIG.-4-3
SIMPLIFIED VERSION OF PUMP STORAGE HYDRO PLANT SCHEDULING INCLUDING THERMAL COST CHARACTERISTIC
SYSTEM THERMAL FUEL COST RUPEES PER HOUR
120000
105000
90000
75000
60000
45000
30000
0
2000
4000
6000
MEGAWATTS
HOURS
0
24
48
72
96
120
144
168
WEEKLY LOAD CYCLE
PUMP
RESERVOIR STORAGE
MAXIMUM STORAGE
MINIMUM STORAGE
FIG.-4-4
MODELING APPROACH USED TO SIMULATE THE EFFECTS OF NUCLEAR FUEL THE PROGRAM CHANGES DATA INTO FUEL COSTS.
CAPACITY FACTORS
FUEL DESIGN DATA
COST DATA
FUEL MANAGEMENT PROGRAM
FUEL COSTS
RELOAD SCHEDULE
PRODUCTION COST PROGRAM
ECONOMIC PROGRAM
CARPORATE MODEL
LOADING PATTERN
NUCLEAR UNIT GENERATION AND RELOADING DATA
FUEL INVENTORY
INVENTORY INTEREST
FUEL EXPENSE
CASH FLOWS
COST FACTORS
FIG.-4-5
THE ACCOUNTING MODEL INCLUDING PERTINENT INCOME TAX CALCULATIONS
ADVANCE MONTH
PRETAX INCOME
TAXABLE INCOME
ESTIMATED INCOME TAXES
NET INCOME & EARNINGS
CASH FLOWS
ADDITIONAL FINANCING
ADDITIONAL INTEREST ?
NO
YES
UPDATE BALANCE SHEET
MONTH ?
JAN
NOV
DEC
COMPLETED
STOP
ANNUAL INCOME TAXES
DEC.
NOV.
REPEAT MONTH
REPEAT DEC
POWER ECONOMY COMMITTEE

GENERATION SCHEMES FOR IMPLEMENTATION DURING THE FIFTH AND SIXTH PLANS

1. *Continuing schemes from the Forth Plan:*

Scheme	Installed capacity (MW)	Status of Investigation
NORTHERN REGION		
Hydro		
1. Dehar (Punjab/Haryana/Rajasthan)	495	Investigations completed.
2. Pong (Punjab/Haryana/Rajasthan)	240	-do-
3. Yamuna Stage II (U. P.)	120	-do-
4. Maneri Bhali Stage I (U. P.)	105	-do-
5. Ramganga (U. P.)	60	-do-
6. Yamuna Stage IV (U. P.)	20	-do-
7. Lower Jhelum (J & K)	96	-do-
8. Salal (J & K) (Central Scheme)	270	-do-
Total Hydro	1406	
Thermal		
1. Bhatinda (Punjab)	110	-do-
Total Thermal	110	
Total benefits from schemes continuing from the Forth Plan	1516	
SOUTHERN REGION :		
Hydro		
1. Lower Sileru (Andhra Pradesh)	400	-do-
2. Srisailam (Andhra Pradesh)	440	-do-
3. Pandiar Punna Puzha (Tamil Nadu)	100	-do-
4. Idikki 3rd Unit (Kerala)	130	-do-
Total Hydro	1070	
EASTERN REGION		
Hydro		
1. Subarinrekha (Bihar)	65	-do-
Toal Hydro	65	
All-India Total benefits from continuing schemes	2651	

II. *New Schemes :*

Schemes	Installed capacity (MW)	Status of Investigation
1	2	3
NORTHERN REGION:		
Hydro		
1. Shanan Extn. (Punjab)	50	Investigations completed and report submitted to CWPC.
2. UBDC Extn. (Punjab)	45	-do-
3. Thein (Punjab/J &K)	210	-do-
4. Nangal Right Bank (Punjab, Haryana and Rajasthan)	150	-do-
5. Vishnu Prayag (U.P)	200	Investigations completed. Project report under preparation by State.
6. Maneri Bhali Stage II (U P)	200	
7. Gangbal (J & K)	60	Under investigation. Likely to be completed in 1971.
8. Sonamarg/Kangan (J & K)	50	Investigations completed and project report submitted to CWPC for Kangan Project. Sonamarg Project under investigation.
9. Pakal Dhul (Marusudar) (J &K)	260	Investigations under completion. Project report likely to be prepared and submitted in 1971.
10. Kishtwar Stage I (Chenab) (J & K)	200	-do-
11. Seawa (H.P.)	100	Under investigation. Likely to be completed in 1971.
Total Hydro	1525	
Thermal/Nuclear		
1. Bhatinda Extn. (Punjab)	200	Extension at site under development.
2. Faridabad Extn. (Haryana)	55	-do-
3. Badarpur Extn. (Delhi)	200	Extensions at developed sites.
4. Delhi 'C' Extn. (Delhi)	55	-do-
5. Obra Extn. (U.P.)	600	-do-
6. Nuclear (Central Project)	400	Site to be selected.
Total Thermal/Nuclear:	1510	
Total benefits from New Schemes.	3035	
WESTERN REGION:		
Hydro		
1. Kadana (Gujarat)	240	Site investigated and irrigation portion under construction. Revised report on power aspect submitted.
2. Pumped Storage (Gujarat)	200	Site to be selected near Ukai Reservoir and investigated.

1	2	3
3. Bhira Tail-race (Maharashtra)	80	Project sanctioned for implementation.
4. Tilari (Maharashtra)	60	Investigated and report submitted to CWPC.
5. Pench (Maharashtra)	160	-do-
6. Pumped Storage (Maharashtra)	500	Site to be selected and investigated.
7. Narmada Sagar (MP)	600	Investigated and report submitted to CWPC.
8. Bodhghat (MP)	240	-do-
9. Dudh Sagar (Goa)	30	Investigations completed, report under preparation.
Total Hydro :	2110	
Thermal/Nuclear:		
1. Nuclear in Gujarat	600	Site to be selected.
2. Ukai Thermal Extn. (Gujarat)	200	Extension at site under development.
3. Nuclear in Western (Maharashtra)	1000	Site to be selected.
4. Koradi/Nasik Extn. (Maharashtra)	1400	Extension at site under development.
5. Korba Extn. (M.P.)	400	Extension at developed site.
Total Thermal/ Nuclear :	3600	
Total benefits from New Schemes	5710	
SOUTHERN REGION :		
Hydro		
1. Upper Sileru Extn. (AP)	120	Extension at developed site.
2. Lower Sileru Extn. (AP).	200	Extensions at site under development.
3. Nagarjunasagar Pumped Storage (AP)	100	Scheme recommended for sanction by *Ad-hoc* Committee.
4. Kadamparai (Tamil Nadu)	100	Investigation under completion.
5. Cholatipuzha (Tamil Nadu/Kerala)	60	Investigated and report submitted to CWPC.
6. Suriliar (Tamil Nadu)	35	-do-
7. Upper Thambraparapi (Tamil Nadu)	30	-do-
8. Idikki Extn. (Kerala)	390	Extensions at site under development.
9. Silent Valley (Kerala)	120	Investigated and reported submitted to CWPC.
10. Idamalayar (Kerala)	50	Investigated and report submitted to CWPC.
11. Kalinadi Ist Phase (Mysore)	260	Scheme recommended for sanction by *Ad-hoc* Committee.
12. Kalinadi further development (Mysore)	650	Investigations under completion. Likely to be completed in 1971.

1	2	3
13. Varahi (Mysore)	300	Investigated and project report prepared by State Authorities.
14. Sharavathi Dam & Tail Race (Mysore)	300	-do-
Total Hydro :	2715	
Thermal/Nuclear :		
1. Kothagudam/Ramagundam Extn. (AP)	400	Extensions at developed site
2. Neyveli Extn. (Tamil Nadu)	400	-do-
3. Nuclear (Central Scheme)	600	Site to be selected.
Total Thermal /Nuclear.	1400	
Total benefits from New Schemes	4115	
EASTERN REGION :		
Hydro		
1. Koel Karo, 1st Stage (Bihar)	720	Investigated. Revised Report under preparation.
2. Konar and other pumped stoarge (DVC)	300	Sites to be located and investigated.
3. Upper Kolab (Orissa)	150	Under investigation.
Total Hydro :	1170	

III. Hydro-schemes for benefits for the Sixth Plan :

Scheme	Installed capacity (M.W.)
NORTHERN REGION :	
1. Kishan Dam (U.P.)	600
2. Pancheshwar (U.P.)	2000
3. Poornagiri (U.P.)	1000
4. Tehri/Kitli-Bhel (U.P.)	800
5. Tapoban-Vishnugarh (U.P.)	150
6. Vishuprayag-Pipalkoti (U.P.)	100
7. Bhatwari (U.P.)	50
8. Lata (U.P.)	50
9. Bursan (J.K.)	200
10. Sawalkot (J.K.)	400
11. Parbaiti (H.P.)	2000
12. Dharari Diversion (H.P.)	200
13. Baspa (H.P.)	60
14. Thirot (H.P.)	120
15. Raoli (H.P.)	300
16. Bardang (H.P.)	60
17. Seli (H.P.)	100
18. Schemes in Upper Sutlej Basin (H.P.)	500
TOTAL	8690

NOTE :—Extensions at the following sites which would have developed by the end of the Fifth Plan would be possible during the Sixth Plan.

Scheme	Installed capacity (MW)	
Thermal		
1. Patratu Extn. (Bihar)	200	Extension at developed si
2. Thermal in North Bihar	120	Site to be located-can be Barauni which is a develo site.
3. Chandrapura Extn. (D.V.C.)	240	Extension at developed site.
4. Thermal in West Bengal	600	Can be located at sites develo and under-development.
5. Talcher Extn. (Orissa)	240	Extension at developed site.
Total Thermal :	1400	
Total benefits from New Schemes.	2570	
NORTH EASTERN REGION :		
Hydro		
1. Loktak Extn. (Manipur)	35	Extension at site under devel ment.
2. Kameng Stage I (NEFA).	100	Under investigation. Proj report under preparation.
3. Kyrdemkolai (Assam)	60	Investigated and report su mitted-sanctioned.
Total Hydro :	195	
Thermal		
1. Namrup (Assam)	30	Extension at developed site.
Total Thermal ;	30	
Total benefits from New Schemes :	225	
All India Total Benefits from New Schemes:	15660	

Scheme	Installed capacity (M W)
1. Dehar	330
2. Thein	210
3. Pakal Dhul	390
4. Kishtwar	200
Total	1130
WESTERN REGION :	
1. Wainganga (Maharashtra)	600
2. Pumped-Storage Scheme (Maharashtra)	500
3. Kotri-Nibra (Maharashtra/MP)	400
4. Bhopalapatnem (Maharashtra/MP)	400
5. Pumped Storage Schemes (Gujarat).	500
6. Chitrakot (MP)	150
7. Kutru (MP)	300
8. Majimendri (MP)	500
9. Schemes on Narmada (MP)	600
10. Ken (MP)	300
11. Kanhar (MP)	100
Total	4350
NOTE: —In addition extensions at the following sites, which would have been developed by the end of the Fifth Plan, would be possible during the Sixth Plan.	
1 Narmadasagar	400

Scheme	Installed capacity (MW)
SOUTHERN REGION :	
1. Lower Periyar (Kerala)	150
2. Kakkad (Kerala)	50
3. Parinjakutti (Kerala)	350
4. Lakshmi (Kerala)	30
5. Puyankutti (Kerala)	100
6. Poringalkutin R. B. (Kerala)	100
7. Lower Chalakudy (Kerala)	100
8. Bedti (Mysore)	400
9. Sorda (Mysore)	200
10. Aghanashini (Mysore)	300
11. Barapole (Mysore)	150
12. Mahadayi (Mysore)	50
13. Kauvery Schemes (Mysore/Tamil Nadu)	600
14. Pumped Storage Schemes (Tamil Nadu)	500
15. Schemes in Pranhita and Lower Godavari (A. P.)	1000
Total	4080
EASTERN REGION:	
1. Lower Shan (Bihar)	300
2. Tihkerapara (Orissa)	500
3. Upper Indravati (Orissa)	400
4. Barakot (Orissa)	100
5. Lower Kolab (Orissa)/MP)	120
6. Pumped Storage Schemes	500/1000
7. Lower Karo (Bihar)	100
Total	2020/2520
NOTE :—In addition, it would be possible to add capacity during the Sixth Plan at the following sites which would have been developed by the end of the Fifth Plan.	
1. Koel Karo (Bihar)	220
NORTH-EASTERN REGION :	
1. Kameng Stage II (NEFA)	200
2. Umkhen (Assam)	300
Total	500
All-India Total Benefits from Advance Action:	19640/20140 MW

APPENDIX 6
PERFORMANCE BUDGETING

1. Performance budgeting is essentially a process whereby the projects/activities of the performing units are converted into organisational work and financial responsibilities. It is a reflection of what the organisation is doing, and what the costs are. It focusses attention on the ends to be served rather than on the amount of money to be spent. In the formulation of a performance budget the most important single task is the precise definition of the work to be done and a careful estimate of what that work will cost. The proposed work, its purpose and related costs are developed as part of the long term goals and programmes such as those contained in the development plans.

2. The performance budget document is prepared on the basis of functions and objectives of the several agencies and departments rather than exclusively on the basis of objects of expenditure and organisational units. A function, for this purpose, has been defined as a major division of the total organised effort the purpose of which is to provide a distinct public service. A programme represents a segment of a function and an activity/project represents the division of a programme into homogeneous types of work.

3. *Principal components of performance Budgeting* :

3.1. Executive budget programming requires that individual agency programmes should be formulated and considered in terms of the programme as a whole and should be in accordance with the policies established by the executive. A sound work programme for a specified time period, should include, for each activity, a clear definition of objectives, the choice of basic methods for achieving the objectives, a forecasting of how much and what kind of work is to be done, when and at what cost. Consequently, the first step towards performance budgeting is the establishment, improvement and extension of a..ctivity, schedules stating the major purposes to be served, the identification of programmes geared towards ends, indication of projects/activities under each programme and the measurement of the volume of work with data on past, current and anticipated work-load. These measures should be countable, clear, reflection of the important resources used and should be set forth in functional terms. If the organisational structure corresponds to the functional framework of an agency or department, it will facilitate the decentralisation of budgeting programme and financial responsibility at every level within the organisation.

3.2. The second step towards Performance Budgeting is the installation of work measurement and the application of performance standards without which performance budgeting could be defeated within the administrative agency. It is, however, recognised that there is no single yardstick for measuring activity or for determining performance standards. Some agencies can use work-load and unit cost data; others can use work-load data; still others can use only explanatory or descriptive material. Agencies at different stages of development should be encouraged to devise and use the most suitable methods for a given programme and move progressively towards higher levels of perfection. Determination of a suitable standards should be based on a cimplete understanding of the nature of work and past records of similar work. Any standard so derived should be tentative allowing for deviations. After having allowed for such deviations, the variances between actual and standard performance would suggest some corrective action thereby enhancing the value of budgeting control.

3.3. The third important step is the establishment of record keeping along functional lines. Such reports would indicate the variance between budgeted and actual costs thereby enabling management to check on the work accomplished. Obviously, behind every such variation there must be reasons in operating conditions. Some of these are remediable and others non-remediable. Where the variation is due to remediable factors timely and suitable actions could be taken to eliminate the gap. An ideal reporting system should cover the volume, quality, time expended and costs of each programme or activity. But even the weakest should contain at least the data regarding the volume of work-load for each activity.

4. An efficient system of information and reporting pre-suppose an adequate and proper accounting support. Basically, there must be an integration of budgeting and accounting classifications. Accrual accounting should be used wherever appropriate. But in view of the difficulties involved in determining costs and expenses in relation to changes in assets and liabilities, the switch-over to accrual accounting should be properly phased over a fairly long period. Similarly, trading services and enterprises should be equipped with business-type accounts and costing systems wherever feasible. Ideally, commercial accounting will be reliable and complete only when they are on a double entry basis and a balance sheet prepared at the end of the year. Hence, every step towards the adoption of double-entry system and accrual accounting may be regarded as a gain in precision and completeness. It should be recognised that accounting is an administrative function which should be decentralised within the agenies to the degree practic-

able in terms of delegated operating responsibilities and the desired degree of centralised control. In short, performance budgeting calls for a vastly improved accounting system which will enable all responsible persons to appraise the value of programmed activities in the light of programme costs and accomplishments.

5. There must be an improved organisation and programme management to take full advantage of the data made available through performance reporting. It should be the constant endeavour of the higher organs of the executive to evolve new methods, procedures, techniques of operation and systems of internal audit etc., as to use the available data for meaningful reviews and analysis of the activities with a view to improving their effectiveness and economy in operations.

6. An important element in Performance Budgeting is that types of expenditures which are essentially different in character such as capital outlays and current operating cost should be presented, justified and authorised separately under each major programme in the budget. A capital cost is an expenditure for the acquisition, such as land, buildings, plant or machinery. An operating cost is an expenditure other than a capital cost incurred in carrying out a specific programme or activity. These two types of costs are different in character and, in programme budget, should appear separately under each major activity. While capital project may be carefully analysed for usefulness, timelines and total probable costs at the time of original authorisation, the total remaining costs of all capital projects should be set forth in the budget. each year, together with costs incurred to-date. These costs should be revised in succeeding years to keep them current with later developments.

6.1. It is true, that 'above the line and below the line' distinction is made in the traditional accounting practices prevalent in several countries. But, this is done mainly with a view to distinguish between the revenue financed and loan financed segments of the expenditure rather than to rationalise the budget in terms of strictly economic categories.

7. In logical terms, uniformity in classification at all stages of the budgetary process should be extended to the appropriation structure as well. The structure of appropriation which provides the life blood for those activities should be in accordance with the underlying purposes of long-range planning and programme control.

8. Ideally, in the establishment of a Performance budget system, all these elements of improvement should move forward simultaneously. Ths is especially desirable since all these elements stand together. In practice, however, no one aspect of Performance budgeting should remain static merely because some other point in imperfect, for improvement in one area stimulates and encourages other improvements and the inter-action of all will finally determine the level of accomplishment.

APPENDIX 7

USE OF PERT/CPM TECHNIQUES IN PROJECT MANAGEMENT

1. Advent of Programme Evaluation and Review Techniques (PERT) and critical path method (CPM) for scheduling techniques and their application to project implementation and now recognised as the greatest single advance in construction management outside the phenomenal progress in developing new and versatile construction equipment. The most far-reaching effect of this has been to compel the project managers as well as Contractors to really plan the work in advance of starting the work in the field. The creation of a PERT/CPM Network is, once all the facts are at hand, a simple mathematical process.

2. PERT/CPM is based on establishing the entire set of activities involved in a project, the inter-relationships between them and time estimates for each activity. Mathematical analysis of the network so established enables the determination of the final completion date, earliest start and latest start and earliest finish and latest finish dates for each activity, effect of exceeding activity time estimates on the overall schedule etc. This enables close and effective management control.

3. Planning must be done before the project can be intelligently scheduled. The length of any activity in the overall work process depends on the methods employed as well as the equipment and manpower to bring it about. One combination of men and machines may complete any given part of the work in much less time than other combinations. On the other hand, an alternate selected method may require a longer time but be the more economical. The ideal is that method which requires the least time and is also the most economical in the long run.

4. Scheduling is a mechaical process for formalizing the planning functions, assigning time boundaries for each part of the work in such a manner that the work proceeds in logical sequence and in an orderly and systematic manner. On most works, a certain amount of rescheduling must be done during the progress of the job. This occurs most frequently on projects containing a great deal of mechanical and electrical work where the materials and equipment are not available from stock but must be fabricated or assembled on special order or on work where there has not been previous experience either in design or in construction.

4.1. A successful construction operation implies that the work is to proceed more or less as an assembly-line process so that all parts and functions, like gears in a machine, silently and smoothly do their job in the most efficient and economical manner. In such an assembly-line process, each little part or function is designed for the job it has to do, interlocking and meshing with others to operate as a continuous and contigeous whole.

4.2. Preparing the schedule is, more or less an assembly-line process. Functions follow one another in a logical and necessary sequence which may be generally outlined as follows :—

(1) Securing copies of the contract documents including the plans, specifications, special provisions, contract agreement, general conditions, along with the agreed upon completion date if this available.

(2) Breaking the work down into its various work classifications or main divisions and sub-divisions, then listing them in regulated sequence as a basis for the master schedule.

(3) Determining the dates on which final drawings and specifications are needed or wll become available.

(4) Listing the items of materials and institutional equipment required for the permanent part of the work by either work classifications or other sub-divisions of the work as set forth in the master schedule.

(5) Preparing a detailed set of bills of materials for the above items entering into the permanent part of the work.

(6) Determining the possible delivery dates for equipment and materials listed on the bills of materials.

(7) Selecting the methods to be used for each part of the work based on alternate-methods analysis to determine the most economical one and to arrive at working and calendar days to complete. Those are the activity times as required by a CPM network.

(8) Preparation of a preliminary schedule based on the information available at this stage.

(9) Review and issuance of project work schedule-Issue No. 1.

4.3. This whole procedure can be initiated at the bidding stage and as soon as a quantity survey and estimate are available if it is required that a schedule be presented with the bid.

4.4. Typical PERT Networks for a Hydro-and-Thermal Projects are attached as fig. 7-1 and 7-2.

5. A PERT/CPM Network can be established to include even the initial activities of planning (prior to project sanction) which can cause as much or even greater delay if not carefully monitored. Since all power projects of a specific type are more or less identical as far as activities are involved, drawing up a PERT/CPM network in early stages is not difficult. In fact, standardized PERT/CPM networks could be established for each type of project. Secondly, PERT/CPM Networks covering overall planning activity could be integrated into the individual project execution activity.

6. A computer can analyse very large networks in a short time and can give output reports that are useful for all levels of management from summary reports for top management to the detailed activity reminders to the lower most supervising groups. PERT/CPM network should therefore, be drawn in great detail so that each activity can be clearly and unambiguously identified with the person or group responsible for its execution. Assigning a unit of work to each activity, the overall progress can be determined in quantifiable terms. The mathematical basis for optimisation of the network schedule is operations research procedure known as parametric linear programming. Computer methods are already available for carrying out such work.

7. Considering, however, the fact that the use of PERT/CPM methods are now to be newly introduced in the project management work in this country, "manual" methods can be used very advantageously as a first step. Initial introduction of non-computer methods need not be considered a step backward; rather it is a desirable intermediate step for our project management, who have to familiarise themselves with the requirements and potentialities of these new techniques and to equip the project organisations for the continuous demands that would be made on them by adoption of these methods.

7.1. A manual approach, it is felt, would encourage a much more wide-spread application of the PERT/CPM for problems of moderate complexity involving original project planning, subsequent revisions of project planning, project control and contract change settlements. A great majority of the tasks may be expected to rail in this category. As familiarity with these, methods grows and more complex problems are undertaken, the use of computers would naturally become the next logical step to be taken.

7.2. A step-by-step manual method allows the planner to retain more judgment control in making changes in the input data. It permits to pick a starting point that limits range over which approximation must apply. With the computer, all the input data must be supplied at the outset, while with the manual approach, the introduction of new data is allowed as the schedule develops. The simplified computer approach assumes that each operation in independent except for the sequential relationships indicated by the Project Network. Actually, cost interactions between operations frequently result when schedule changes are made. The manual project permits the planner to experiment with such changes that may affect several operations rather than just one.

7.3. The main disadvantage in working in this manner would be the inconvenience of frequently updating the schedule or in making changes in the project network which may require repeat performance of a portion of the computational work. As against this, a thorough understanding and application of these techniques by the projects and would enable them establish compebeneficial for individual projects and would enable them establish competent PERT/CIM. cells at different levels. These can later establish ties with computer operators in the country for processing PERT/CPM Networks and introducing computerised methods to the extent required.

APPENDIX 8

MANAGEMENT INFORMATION SYSTEM FOR POWER PROJECTS

1. The use fulness of the concept and mechanics of Management Information Systems may be better appreciated when the method of their application to an enterprise, programme or pro-project is illustrated. With this in view, the design of a Management Information System in respect of power projects for use in monitoring the pre-construction and the construction phases of power project development is outlined here. The experience and knowledge gained in the earlier efforts which were concentrated on project planning and control techniques with a view to minimising or eliminating the problems of schedule slippage and cost over-run, have been brought to bear on the design of a Management Information System for power projects.

2. The major problems faced by Power Departments of State Governments/State Electricity Boards and individual project authorities in power project planning, construction and commissioning have been outlined in the main report (Section 17 para 4). These point to the need for systematising the programme scheduling methodology whereby reports of progress could clearly indicate the criticality of taking action in advance to preclude delays.

3. A primary objective of the Management Information System under discussion is to provide to the top management a means for sensing potential bottlenecks and delays in the implementation of the programme. This is required in two forms, viz. (1) from the project level point of view where the top management is the Project General Manager and (2) from the Electricity Board/Deptt./Ministry level point of view where the Chairman SEB/Secretary of the Ministry/Minister is the top management and a number of projects are in hand for the fulfilment of power programme in a particular plan period. Both these need separate attention. The systems outlined here are specifically for the construction phase of a project. Similar, though perhaps simpler, systems should be devised and adopted for the pre-construction phase also

4. *The salient features of the System Design are as follows* :

4.1. The system should provide information on cost and time for use by management in the decision-making process.

4.2 The system may be patterned on the principle of management by exception.

4.3. A major portion of the information and reporting sysem may be based on the use of network technique for controlling the scheduled progress of work at the project level.

4.4. The design should include feed-back reporting into the system.

5. *Information System for an Individual Project*:

5.1. As already discussed elsewhere, a network Scheduling Section should be established from the beginning. Its relationships to the different levels of Project management are depicted in figure below :

TOP MANAGEMENT level 3

PROJECT EXECUTIVES level 2

FIELD LEVEL level 1

NETWORK SCHEDULING SECTION

It is the responsibility of the Network Scheduling Section to establish a continuous monitoring system by measuring the actual performance against scheduled performance and to feed back information. This continuous recycling of feed back information enables the original plan to be rescheduled and adjustments to be made wherever required. The following steps are involved:

(i) Record progress of the project. (Preferably : volume, quality, time expended and costs of each programme or activity in terms of the Performance Budget).

(ii) Analyse the project progress against networks;

(iii) Up-date the networks (on the basis of the computer printout, where available).

(iv) Prepare reports for use of the different levels of management.

5.2. The reports are usually made for three levels of management, viz. (1) the field level of management; (2) the middle level of management, *i.e.* Project executives and branch heads; and (3) the top level of management. These are discussed separately.

5.3. *Reports for Field level of management (Level 1).*

Full activity listing arranged in order of :

(1) Predecessor activity and successor activity .

(2) Least slack in the ascending order of slack.

(3) Expected date-wise—This is sorted in order of expected completion date upto the cut off date (Latter is indicated in the programme).

(4) Latest allowed date.

(5) Organisation code.

(6) Universal subject indexwise sort—This is a coding system used for the project.

Among the six reports, the first two reports are produced on a routine basis in each update run. The remaining reports are produced on request from the concerned agencies.

5.4. *Reports for Middle level of management (level 2) :*

5.4.1. The following reports may be prepared to indicate at a particular period; the status of the project; the delays that are likely to occur; the hold-ups and the corrective measure called for; the financial position corresponding to the progress of the project etc. and the variance between budgeted and actual costs and the reasons therefor (see Appendix 5, Performance Budgeting, paras 3 & 4). The first two reports could be in the narrative form (Annexures 8-3 & 8-4) or in the Network or diagrammatic form (Annexure 8-1).

	Specimen in Annexure
(1) Project Status Report.	8-3
(2) Project Status Analysis.	8-4
(3) Project Cost Report	8-5
(4) Project Quarterly Financial Report	8-6

Alternatively 8-1

These reports should be prepared in adequate detail for use of the management and to meet the monitoring requirements of the branch heads.

5.4.2. In addition to the above reports it will be helpful to establish three displays at this level (Annexure 8-13 to 8-15) for use in monitoring the projects. These displays constitute a device for management to take stock of the overall project status at a glance.

5.5. *Reports for Top level of management (Levels 3):*

5.5.1. This is the medium for reporting the status and difficulties of the project to the top level of management. The reporting system should reveal the overall progress of the project in comparison to the planned and scheduled progress to date and should be selective so that the management need not go through a large volume of information. The presentation should preferably indicate the progress of the project measured by both time as well as cost.

5.5.2. For this purpose, four reports based on the ones designed for level 2, are proposed. These follow the principle of management by exception. First three of these are shown at Annexure 8-7 to 8-9. The Project Quarterly Financially Report would be exactly the same as for level-2 given in Annexure 8-6. As has been mentioned earlier, these reports should contain adequate details for the use of the management and to meet the, monitoring requirements. As an alternative to Annexure 8-7, the Project Status Report, a net work or diagrammatic report as appearing at Annexure 8-2 could be presented. There may also be two displays (Annexure 8-14 & 8-15) instead of three as at level-2 mentioned earlier.

6. *Information System for an authority controlling a number of projects e.g. State Electricity Board, Ministry etc. :*

6.1. The system aims at providing a basis for planning and reporting to the various managerial levels, starting with the Chief Executive of an individual project, flowing upwards to the State Electricity Board and the Power Department Officers, and finally ending with a monthly presentation to Secretary of the Department and the Minister.

There would be three management reporting levels :

(1) Level-1 Reports : Generated and utilised at Project level for planning, decision making and control.

(2) Level-2 Reports : Emanate from the project (level-1 above) and are submitted to the Board and the Power Department/ Ministry.

(3) Level-3 Reports : Emanate from the Power Department (level-2 above) and are submitted to the Secretary of the Deptt. and the Minister.

6.2. *Level* 1 (*Project Level*)— To indicate the progress of the project measured by both time as well as cost, the following four reports as designed for the case of Middle level management under para 5.4 (Annexure 8-3 to 8-6) may be prepared and presented suitably at the project level.

(1) Project Status Report

(2) Project Status Analysis

(3) Project Cost Report

(4) Project Quarterly Financial Report

The three displays (Annexures 8-13 to 8-15) suggested in para 5.4 are recommended in this case also.

6.3. *Level* 2 (*Board and Department Officers*).—There may be four reports at level 2 similar to those designed for Level 3 in the case of individual Project (Annexure 8-6 to 8-9). The objectives of Level 2 Reports which constitute a selective synthesis of Level 1 Reports are to provide an overall view of the project progress and to bring to the attention of the Board Chairman and the Department Officers critical areas or significant problems calling for corrective section. The two displays (Annexure 8-14 & 8-15) suggested under para 5.5 may also be considered for level-2 above.

6.4. *Level* 3 (*Secretary of the Deptt. and the Minister*)

Three reports (Annexures 8-10 to 8-12) at this level may suffice namely :

(1) Project Position;

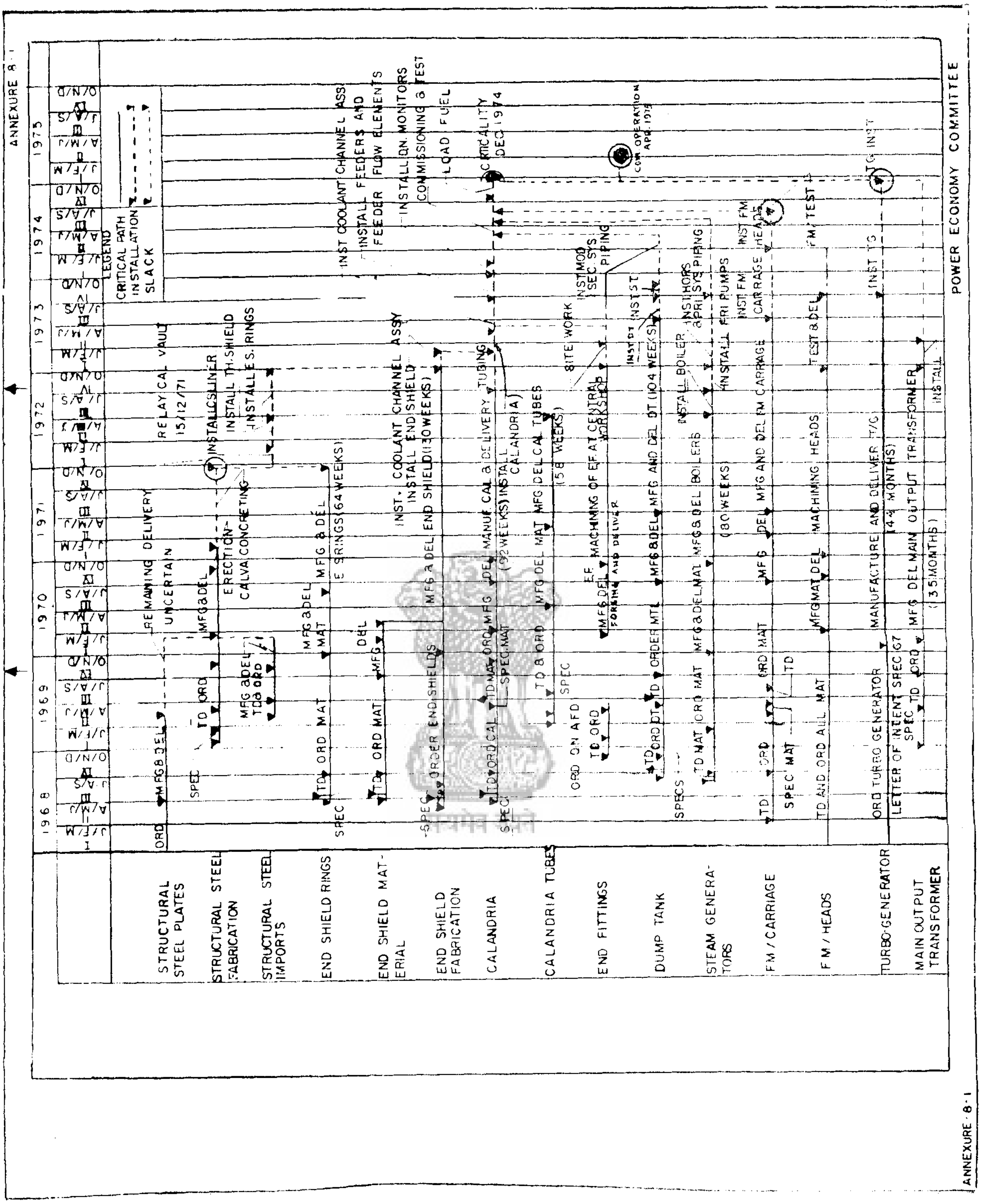
(2) Project position Analysis.

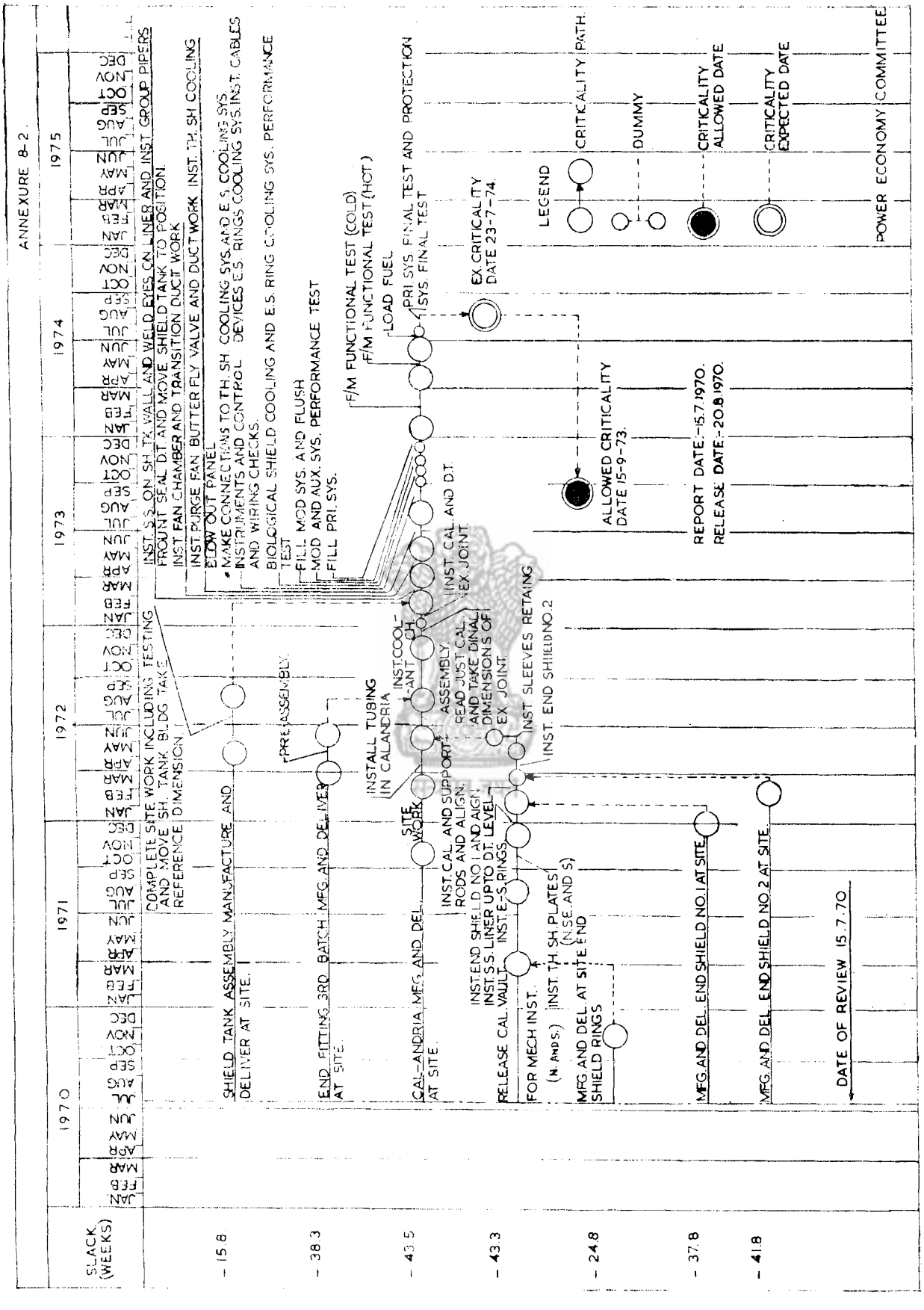
(3) Programme Summary.

These three reports are designed to summarise various aspects of the system and identify problems in the power projects.

7. The above information system may need certain modifications in actual practice. These can be introduced after taking the needs of specific projects into account. It would, however, be desirable not be make too frequent changes.

10—783I&P/71


ANNEXURE 8·1
1968
1969
1970
1971
1972
1973
1974
1975
LEGEND
CRITICAL PATH
INSTALLATION
SLACK
STRUCTURAL STEEL PLATES
STRUCTURAL STEEL FABRICATION
STRUCTURAL STEEL IMPORTS
END SHIELD RINGS
END SHIELD MATERIAL
END SHIELD FABRICATION
CALANDRIA
CALANDRIA TUBES
END FITTINGS
DUMP TANK
STEAM GENERATORS
F M / CARRIAGE
F M / HEADS
TURBO-GENERATOR
MAIN OUTPUT TRANSFORMER
CRITICALITY DEC 1974
COM. OPERATION APR. 1975
POWER ECONOMY COMMITTEE
ANNEXURE 8·1


ANNEXURE 8-2
SLACK (WEEKS)
1970
1971
1972
1973
1974
1975
- 15.8
- 38.3
- 43.5
- 43.3
- 24.8
- 37.8
- 41.8
COMPLETE SITE WORK INCLUDING TESTING AND MOVE SH. TANK. BLDG TAKE REFERENCE DIMENSION
SHIELD TANK ASSEMBLY MANUFACTURE AND DELIVER AT SITE.
PRE ASSEMBLY
END FITTING 3RD BATCH MFG. AND DEL. AT SITE.
INSTALL TUBING IN CALANDRIA
INST. COOLANT CH.
CAL-ANDRIA MFG. AND DEL. AT SITE.
SITE WORK
ASSEMBLY
INST. CAL. AND SUPPORT RODS AND ALIGN.
READ JUST CAL. AND TAKE DINAL DIMENSIONS OF EX. JOINT
INST. CAL. AND D.T. EX. JOINT
INST. END SHIELD NO. 1 AND ALIGN
INST. S.S. LINER UPTO D.T. LEVEL
INST. E-S. RINGS
INST SLEEVES RETAING
INST. END SHIELD NO. 2
RELEASE CAL. VAULT
FOR MECH INST.
(N. AND S.)
INST. TH. SH. PLATES (N.S.E. AND S)
MFG. AND DEL. AT SITE. END SHIELD RINGS
MFG. AND DEL. END SHIELD NO. 1 AT SITE
MFG. AND DEL. END SHIELD NO. 2 AT SITE
DATE OF REVIEW 15.7.70
INST. S.S. ON SH. TK. WALL AND WELD EYES ON LINER AND INST. GROUP PIPERS
FRONT SEAL D.T. AND MOVE SHIELD TANK TO POSITION
INST. FAN CHAMBER AND TRANSITION DUCT WORK
INST. PURGE FAN BUTTER FLY VALVE AND DUCTWORK INST. TH. SH. COOLING
BLOW OUT PANEL
MAKE CONNECTIONS TO TH. SH. COOLING SYS. AND E.S. COOLING SYS.
INSTRUMENTS AND CONTROL DEVICES E.S. RINGS COOLING SYS. INST. CABLES AND WIRING CHECKS.
BIOLOGICAL SHIELD COOLING AND E.S. RING COOLING SYS. PERFORMANCE TEST
FILL MOD SYS. AND FLUSH
MOD AND AUX. SYS. PERFORMANCE TEST
FILL PRI. SYS.
F/M FUNCTIONAL TEST (COLD)
F/M FUNCTIONAL TEST (HOT)
LOAD FUEL
PRI. SYS. FINAL TEST AND PROTECTION SYS. FINAL TEST
EX. CRITICALITY DATE 23-7-74.
ALLOWED CRITICALITY DATE 15-9-73.
REPORT DATE - 15.7.1970.
RELEASE DATE - 20.8.1970.
LEGEND
CRITICALITY PATH
DUMMY
CRITICALITY ALLOWED DATE
CRITICALITY EXPECTED DATE
POWER ECONOMY COMMITTEE

ANNEXURE 8-3

PROJECT STATUS REPORT

FOR PERIOD : SEPTEMBER 1969 DATE : 2nd OCT., 1969.

Project Component	Critical Event	No.	Sched. Compl. Date	Latest Allowable Date	Likely Compl. Date	Slack (—) OR (+) (Weeks)	Reference to Project Status Analysis
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. TOTAL PROJECT	READY FOR COMMISSIONING	17	15-3-71	15-3-71	15-3-71	(—) 8	para—
2. COMMON	FOREIGN EXCHANGE RESERVED	4	3-11-69	10-11-69	17-11-69	(—) 1	para—
3. POWER HOUSE	ENGINEERING AND DESIGN COMPLETE	10	5-9-69	15-9-69	14-10-69	(—) 4	para—
	CIVIL DESIGN COMPLETE	11	30-11-69	7-12-69	28-12-69	(—) 3	para—
	DELY. OF MAIN PLANT	13	20-5-70	20-5-70	20-7-70	(—) 8	para—
4. DAM	START FOUNDATIONS (Delivery Cement Complete)	20	2-11-69	9-11-69	9-11-69	0	para—
	DELY. OF EQPT. (Service Gates)	22	20-6-70	20-6-70	20-8-70	(—) 8	para—
5. LAND							
6. WATER CONDUCTOR	AWARD OF CONTRACT	32	10-9-69	10-10-69	30-10-69	(—) 3	para—
7. TRANSMIS-SION SYSTEM	PREPARATION OF TENDERS	37	16-7-69	15-10-69	15-10-69	0	para—
8. BALANCING RESERVOIR	START WORK AT SITE	43	30-7-69	6-9-69	13-10-69	(—) 5	para—
9. PROJECT SERVICES & FACILITIES	COMPLETE CONSTRUCTION	48	30-11-70	15-12-70	30-12-70	(—) 2	para—
	COMPLETE LAYING OF W. SUPPLY PIPE LINE	50	15-7-70	15-7-70	30-8-70	(—) 6	para—

PROJECT STATUS ANALYSIS

FOR PERIOD SEPTEMBER, 1969 DATED 2nd OCTOBER, 1969.

I. *LATE OR PENDING EVENTS WITH PROJECT IMPACT* :

A. CRITICAL EVENT : (Name and No.)

1. DESCRIPTION OF PROBLEM
2. IMPACT
3. ACTION TAKEN OR IN PROGRESS
4. ACTION REQUIRED/RECOMMENDED

B.....

C.....

II. *CRITICAL EVENTS ACHIEVED LATE WITH PROJECT IMPACT* :

A. CRITICAL EVENT : (Name and No.)

1. DESCRIPTION OF PROBLEM
2. FUTURE EVENTS AFFECTED

B.....

C.....

III. *LATE OR PENDING CRITICAL EVENTS WITHOUT PROJECT IMPACT* :

A. CRITICAL EVENT : (Name and No.)

1. DESCRIPTION OF DELAY FROM SCHEDULED DATE
2. POSITIVE SLACK (DIFFERENCE BETWEEN LIKELY COMPLETION DATE AND LATEST ALLOWABLE DATE)
3. ACTION TAKEN OR IN PROGRESS
4. ACTION REQUIRED/RECOMMENDED.

B.....

C.....

IV. *CRITICAL EVENTS ACHIEVED LATE WITHOUT PROJECT IMPACT AND CRITICAL EVENTS ACHIEVED ON SCHEDULE* :

A. CRITICAL EVENT : (Name and No.)

1. SCHEDULED DATE
2. ACTUAL COMPLETION DATE

B.....

C.....

V. *FINANCIAL* :

VI. *GENERAL* :

PROJECT COST REPORT

FOR PERIOD : DATE :

COST SUB-DIVISION	Original Project Estimate		Additions Firm		Additions Identified		Project Cost at Completion		Expended to date		Overrun (+) or Under-run(—)	
	Rs.	FE	Rs.	FE	Rs.	FE	Rs.	FE	Rs.	FE	Rs.	FE
1. EQUIPMENT ERECTION												
.POWER PLANT												
.DAM												
.TRANSMISSION & DISTRIBUTION												
.SERVICE EQPT.												
.CONSTRUCTION EQPT.												
.WATER CONDUCTOR												
.BALANCING RESERVOIR												
2. CIVIL WORKS												
.POWER HOUSE												
.DAM												
.B. RESERVOIR												
.WATER CONDUCTOR												
.TRANS												
3. LAND & DEVELOPMENT												
.LAND												
.LAND DEVEPT.												
4. TOWNSHIP												
5. SERVICES & FACILITIES												
.ADM. BLDGS.												
.PIPING												
.RAILWAY												
.POWER												
.LAB/WORK SHOPS												
.SPARES												
.OTHERS												
TOTAL												

FE : Foreign Exchange

PROJECT QUARTERLY FINANCIAL REPORT

FOR PERIOD : DATE :

COST SUBDIVISION		Expended to Beginning of Quarter	Expended during Quarter	Estimated Expend next Quarter	Est. Expend Fiscal	Est. Expend Fiscal	Est. Expenditure End Project
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. EQUIPMENT	Rupees						
	Foreign Exchange						
2. CIVIL WORKS	Rupees						
	Foreign Exchange						
3. UTILITIES/ SERVICES	Rupees						
	Foreign Exchange						
4. TOWNSHIP	Rupees						
	Foreign Exchange						
5. MISCELLA-NEOUS	Rupees						
	Foreign Exchange						
6. DEPARTMEN-TAL CHARGES	Rupees						
TOTAL	Rupees						
	Foreign Exchange						

PROJECT STATUS REPORT

FOR PERIOD : SEPTEMBER 1969 DATE : OCT. 4, 1969

Ready for Commissioning	Original Date 1-12-70	Current Date 15-3-71		Likely Date 15-5-71		Slack (Weeks) (—) 8	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Project Components	Critical Events	No.	Sched. Compl. Date	Latest Allowable Date	Likely Completion Date	Slack Minus (Weeks)	Ref. to Project Status Analysis
1. POWER HOUSE	.ENGINEERING & DESIGN COMPLETE	10	5-9-69	15-9-69	14-10-69	(—) 4	para—
	CIVIL DESIGN COMPLETE	11	30-11-69	7-12-69	28-12-69	(—) 3	para—
	DELY. OF MAIN PLANT	13	20-5-70	20-5-70	20-7-70	(—) 8	para—
2. DAM	.DELIVERY OF EQPT. (SLUICE GATES)	22	20-6-70	20-6-70	20-8-70	(—) 8	para—
3. WATER CONDUCTOR	AWARD OF CONTRACT	32	10-9-69	10-10-69	30-10-69	(—) 3	para—
4. BALANCING RESERVOIR	START WORK AT SITE	43	30-7-69	6-9-69	13-10-69	(—) 5	para—
5. TRANSMISSION SYSTEM							
6. PROJECT SERVICES FACILITIES							
7. LAND							
8.							

ANNEXURE 8-7 POWER ECONOMY COMMITTEE

PROJECT STATUS ANALYSIS

FOR PERIOD : SEPTEMBER 1969 DATE : 4TH OCT., 1969.

I. *LATE OR PENDING EVENTS WITH PROJECT IMPACT*

A. EVENT : (Name and No.)

1. DESCRIPTION
2. PROBLEM/IMPACT
3. ACTIONS TAKEN
4. ACTIONS REQUIRED/RECOMMENDED

B.....

C.....

II. *GENERAL :*

(OTHER INFORMATION ON STATUS, ACHIEVEMENTS, COMMENTS, ETC.)

11—783 I &P/71

ANNEXURE 8-9

PROJECT COST REPORT

FOR PERIOD : DATE :

COST SUB-DIVISION		Original Estimate	Additions Firm	Additions Identified	Estimated cost at Completion	Expended to Date	Overrun (+) OR Underrun (—)
1. EQUIPMENT	Rupees						
	Foreign Exchange						
2. CIVIL WORKS AND LAND	Rupees						
	Foreign Exchange						
3. UTILITIES/ SERVICES	Rupees						
	Foreign Exchange						
4. TOWNSHIP	Rupees						
	Foreign Exchange						
5. MISCEL-LANEOUS	Rupees						
	Foreign Exchange						
6. DEPART-MENTAL CHARGES	Rupees						
	Foreign Exchange						
TOTAL	Rupees						
	Foreign Exchange						

ANNEXURE 8-9 POWER ECONOMY COMMITTEE

ANNEXURE - 8-9A

POWER ECONOMY COMMITTEE

MANAGEMENT SUMMARY REPORT.

U.S.I. NO	SYSTEM DESCRIPTION	COST OF WORK.					SCHEDULE																																									
		WORK PERFORMED TO DATE		TOTAL AT COMPLETION			%COMPLETION										E - EARLIEST COMPLETION L - LATEST COMPLETION S - SCHEDULE COMPLETION																													
		PLANNED COST	ACTUAL COST	PLANNED COST	PROJECTED COST	OVERRUN/UNDERRUN	10	20	30	40	50	60	70	80	90	100	JAN	MAR	MAY	JUL	SEP	NOV	JAN	MAR	MAY	JUL	SEP	NOV	JAN	MAR	MAY	JUL	SEP	NOV	JAN	MAR	MAY	JUL	SEP	NOV	JAN	MAR	MAY	JUL	SEP	NOV

ANNEXURE 8-10

PROJECT POSITION

FOR PERIOD : SEPTEMBER 1969 DATE : 8TH OCT., 1969

—ALERT SYSTEM—

S. No.	Prjoect	Critical Events PROBLEMS	Latest Allow-able Date	Minus Slack (Weeks)	Responsi-ble Agency	Reference to Project Position Analysis
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	X-Y-Z	DELIVERY OF MAIN PLANT FOR POWER HOUSE	20-5-70	(—) 8		para—
		DELIVERY OF EQUPT. (SLUICE GATES) FOR DAM	20-6-70	(—) 8		para—
2.	K-L-M					
3.	P-Q-R					
4.	E-F-G					

ANNEXURE 8-10 POWER ECONOMY COMMITTEE

ANNEXURE 8-11

PROJECT POSITION ANALYSIS

FOR PERIOD : SEPT. 1969 DATE : OCT. 8, 1969.

REF. 1	PROJECT	CRITICAL EVENTS	LATEST ALLOWA-BLE DATE	ESTIMATED DATE	IMPACT (WEEKS)
	X-Y-Z	POWER HOUSE MAIN PLANT DELIVERY	20-5--70	20-7-70	(—) 8

.PROBLEM :

.ACTION TAKEN :

.ACTIONS REQUIRED/RECOMMENDED :

.MANAGEMENT DECISION

	PROJECT	CRITICAL EVENTS	LATEST ALLOWABLE DATE	ESTIMATED DATE	IMPACT (WEEKS)
	X-Y-Z	DAM-EQPT. DELY. (SLUICE (GATES)	20-6-70	20-8-70	(—) 8

.PROBLEM

. ACTION TAKEN

.ACTION REQUIRED/RECOMMENDED :

.MANAGEMENT DECISION :

ANNEXURE 8-11 POWER ECONOMY COMMITTEE

P AMME SUMMARY

DATE :

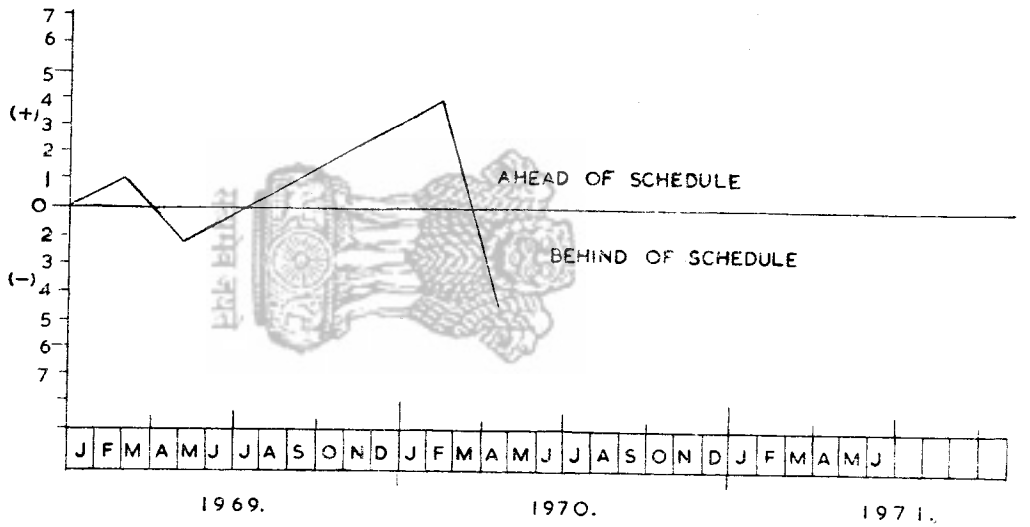
S. No.	PROJECT	COST			SCHEDULE					
		ORIGINAL COST IMPACT	ADDITIONS	CURRENT ESTIMATE AT COMPLETION	EN- / E	PERCENT CURRENT ESTIMATE EXTENDED	ORIGINAL SCHEDULE DATE	CURRENT SCHEDULE DATE	LIKELY COMPLETION DATE	MONTHS BEHIND (—) AHEAD (+)
1	2	3	4	5	6	7	8	9	10	11
1.	X-Y-Z	2877 1026	897	3774 1632	406 5	18·8 0·3	15-3-71	15-3-71	15-5-71	(—) 2
2.	K-L-M									
3.	P-Q-R									
4.	E-F-G									

COSTS :
1st Figure : Total in Rs.
2nd Figure : FE in Rs.
ANNEXURE 8-12

PEC

ANNEXURE 6-14.

PROJECT SCHEDULE TREND/OUTLOOK DISPLAY

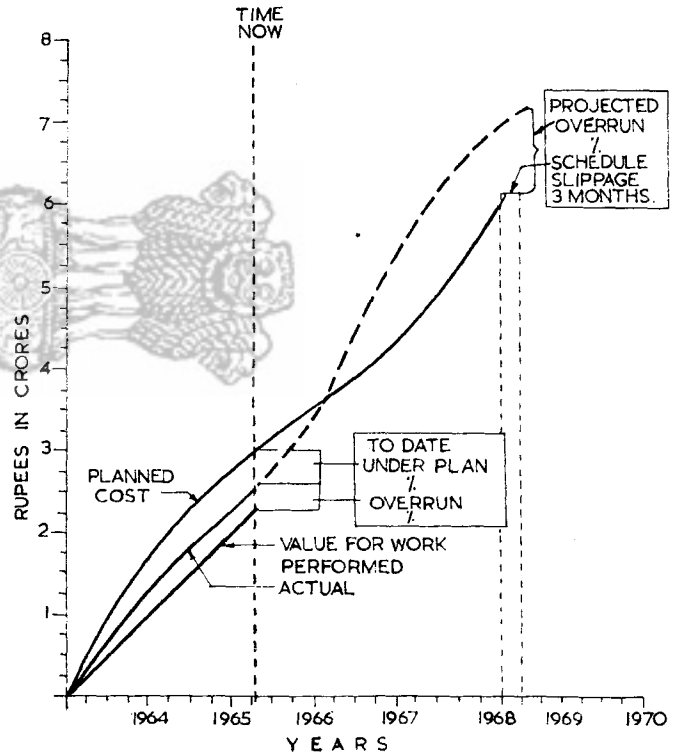


POWER ECONOMY COMMITTEE.

ANNEXURE - 8-15

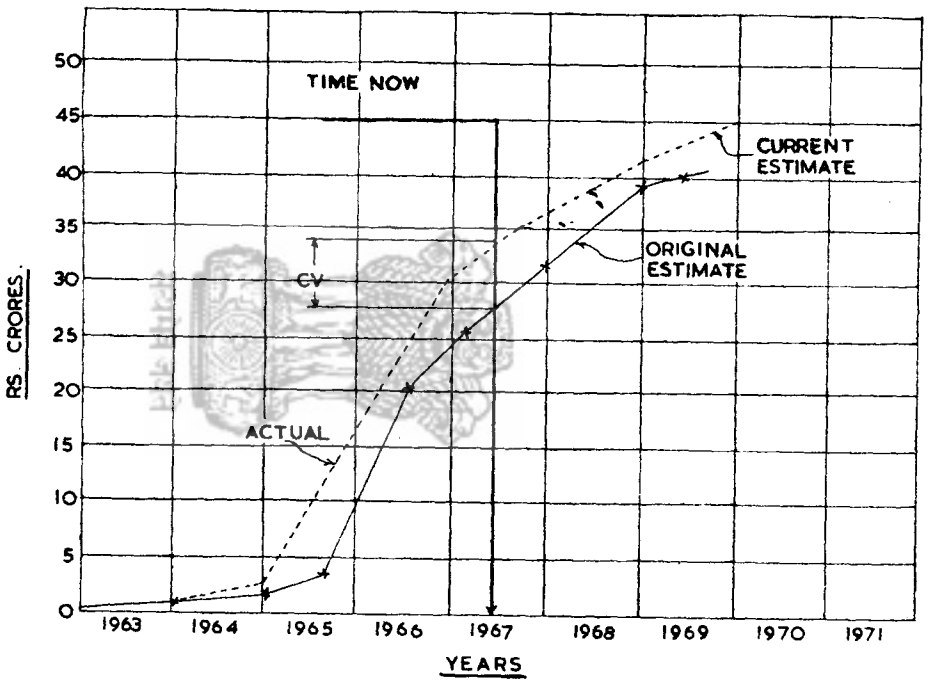
COST OF WORK REPORT

P P E D	PROJECT	REPORT DATE PERIOD RELEASE DATE



POWER ECONOMY COMMITTEE

PROJECT QUARTERLY FINANCIAL OUTLOOK DISPLAY.



ANNEXURE 8-15/A.

COPY

No. 6(5)/69-Policy/Mat.

Government of India
Ministry of Irrigation and Power
New Delhi, the 31st October, 1970

MEMORANDUM

Subject : Appointment of a Committee to report on construction plant and Machinery used in various River Valley Projects in the country.

In October, 1953, the Government of India appointed a Committee of engineers to visit some of the projects then under execution, and submit its report on the economic and efficient operation and maintenance of the plant and machinery used in the construction work of River Valley projects in the country. The Committee submitted its report in February, 1954. Since then, a good deal of equipment has been imported but satisfactory utilisation thereof has been hampered for want of spares etc. It is considered necessary to take stock of the position in regard to the equipment available in the country and its optimum utilisation. The Government of India have, therefore, decided to set up a Committee, with the following composition, for carrying out the study in detail after visits to some of the important projects and establishments :—

1. Shri S. P. Chugh [at present Director (P&M) CW&PC] — Chairman
2. Shri Jagman Singh, Superintending Engineer, Mechanical Circle, Beas Project, Unit-II, Talwara. — Member (Part-time)
3. Shri Gopala Rao, Superintending Engineer, Nagarjunasagar Dam Project, Andhra Pradesh. — Member (Part-time)
4. Shri J. N. Srivastava, Director (Dam II), CW&PC(WW). — (Part-time) Member
5. Shri M. C. Praharaj, Deputy Director (P&M), CW&PC(WW). — Member-Secy.

2. If necessary, the Committee may co-opt members from other interested organisation like National Coal Development Corporation, National Minerals Development Corporation, Hindustan Steel etc. The Committee will be provided necessary supporting staff.

3. The terms of reference of the Committee will be as follows :—

(i) Appraisal of the Construction Plan and Equipment in the country;

(ii) Assessment regarding level of utilisation of available equipment;

(iii) Reasons for low utilisation of equipment and low efficiency in operation;

(iv) Procedure, system and methods of procurement of spare parts and inventory control;

(v) Remedial measures necessary for improving efficiency in the operation of equipment and for optimum utilisation thereof;

(vi) Requirements of equipment in the Fourth Five Year Plan, import substitution and standardisation;

(vii) Inter-departmental co-ordination in matters relating to Construction Plant and Equipment with emphasis on inter-departmental transfer of surplus equipment;

(viii) Training of operators and mechanics—Review of adequacy of present arrangements etc;

(ix) Data on performance of different items of equipment of various categories/makes;

(a) Technical assessment;

(b) Norms for schedules of working hours and life of equipment of various items;

(c) Actual performance of various items of equipment in different projects in various sectors in terms of average annual utilisation and the life usefully spent on different jobs over given periods;

(d) Major repairs and field repairs—Charges over the last ten years, in respect of various items of equipment in terms of

(1) Spare parts; and

(2) Labour.

(x) Hire charges of equipment;

(xi) Maintenance procedures;

(xii) Organisational set-up, including workshop facilities stores and warehouses etc.

(xiii) Organisation and functioning of Central Mechanical Units in Irrigation and Power Sector and similar other establishments, in other sectors;

(xiv) Accounting for the ownership and operating cost per plant hour;

(xv) Recommendations for management, operation and utilisation of construction plant and equipment.

4. The expenditure on T.A. and D.A. in respect of Sarvashri Jagman Singh and Gopala Rao will be met by the Central Water & Power Commission (water Wing) from out of their budget grant.

5. The Committee will submit its report as early as possible but in any case within a period of one year.

Sd/-A.F. Couto
Director (FE&P)

STEPS FOR IMPLEMENTATION OF THERMAL PROJECTS

Thermal power generation programme comprises of the following steps :

(1) Establishing a phased programme for exploitation of fuel resources of the region on the basis of fuel availability and cost of fuel at pit or well head plus the cost of transportation to the load centres in its original form or as electrical energy.

(2) Investigating a set of sites for each of the fuel sources and establishing a phased programme for their exploitation on the basis of cost of generation as influenced by the fuel price as obtained from (1) above and the cost of fuel transport from pit or well head to the generating station, maximum generating capacity that the site can support, water supply availability, ash disposal possibilities, type of foundation possible, local variations in construction costs etc.

(3) For the selected site, determining the parameters for the following :

(1) Foundations
(2) Cycle equipment (Boiler, turbogenerator set, feed water heaters, cycle pumps)
(3) Service and cooling water system
(4) Fuel handling system
(5) Ash handling system
(6) Electrical switchyard
(7) Supporting buildings and services such as roads, drainage etc.
(8) General arrangement
(9) Instrumentation
(10) Electrical auxiliary system
(11) Grounding, cathodic protection
(12) Lighting
(13) Material handling system study
(14) Turbine oil purification system.

(4) Based on the parameters developed in (3) above, initiate procurement action (drawing up specifications, issue of bids, tender analysis, purchases recommendations and placement of orders) and commence preparation of design drawings.

(5) Manufacture, inspection and delivery.
(6) Construction.
(7) Commission and testing.
(8) Project Quarterly Financial.

783I&P/71—1000—14-4-1973—GIPF.